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STABRO LABORATORIES, INC.
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DOCUMENT CONTROL ADMINISTRATOR

8500A/AE

Digital Multimeter

Instruction Manual

P/N 475657
December 1977

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The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90-days), or any product or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

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2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

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*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

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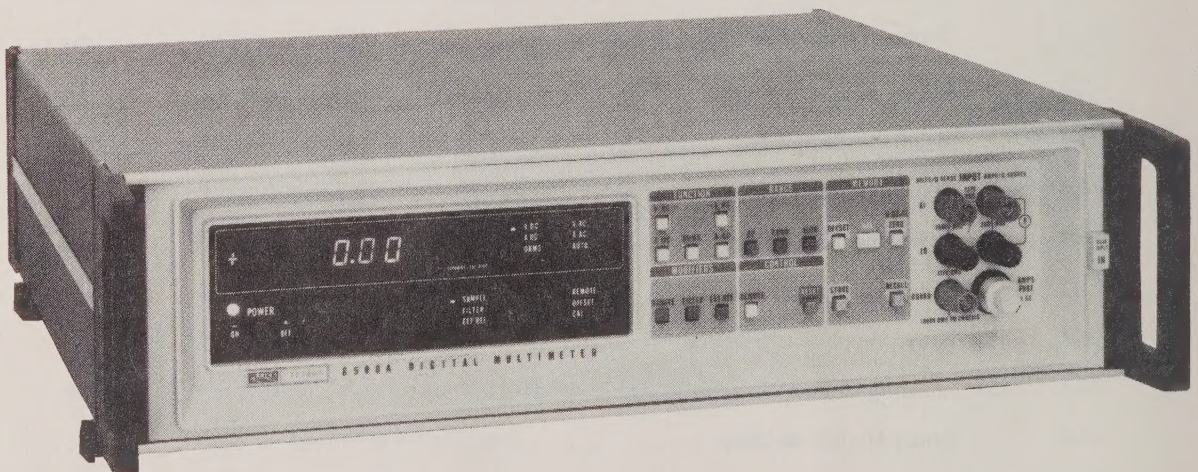
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Model 8500A/AE Digital Multimeter

Section 1

Introduction & Specifications

1-1. INTRODUCTION

1-2. This manual comprises eight modular sections. You will find herein up-to-date information to install, operate, and maintain the Fluke Model 8500A/AE Digital Multimeter. Generally, complete descriptions and instructions are provided for the 8500A/AE mainframe, modules necessary for DC Volts and DC Ratio measurement, and for any optional modules (AC converter, Ohms converter, etc) that you may have ordered with your 8500A/AE. Specifically, each section contains:

1. Section 1 - General description, specifications.
2. Section 2 - Operating instructions, capabilities.
3. Section 3 - Theory of operation, including simplified schematic and functional block diagrams.
4. Section 4 - Maintenance, adjustments and troubleshooting.
5. Section 5 - List of replaceable parts, with parts locators.
6. Section 6 - Option and accessory information, including complete information on any option ordered with the 8500A/AE.
7. Section 7 - General information (list of abbreviations, federal supply codes, Service Centers, and Sales Representatives).
8. Section 8 - Schematic diagrams.

As the need arises to broaden your 8500A/AE's capabilities, the most recent information will be included with any options you order.

1-3. DESCRIPTION**1-4. Modular Construction**

1-5. Considerable versatility is realized through the 8500A/AE's unique construction. Module-motherboard mating, combined with bus architecture and microprocessor control, yields both ease of option selection and reduced downtime.

1-6. Microprocessor Control

1-7. All modules function under direct control of a microprocessor based controller. Each module is addressed by the controller as a memory location. External reference values and offsets can be applied separately, stored in memory, and automatically used as factors in all subsequent readings. Digital filtering utilizes averaged samples for each reading; even multiples of the line frequency determine sample rates.

1-8. Recirculating Remainder A/D Conversion

1-9. The 8500A/AE adapts Fluke's patented recirculating remainder (R^2) A/D conversion technique to microprocessor control. This combination provides fast, accurate, linear measurements and long-term stability.

1-10. Options and Accessories

1-11. Remote interfaces, AC converters, current shunts and an ohms converter are among the numerous options and accessories available for the 8500A/AE. Refer to Tables 1-1 and 1-2 for complete listings. AC conversion can be accomplished with either an averaging module (01) or a true RMS module (09). Any one of three remote interface modules (05, 06, 07) may be installed at one time; the isolator module (08) must then be installed to maintain guarding of analog and high quality buses during remote operations. Maximum interfacing with digital systems is thus realized. Calibration downtime is reduced through the use of a

calibration memory module (04); correction factors may be entered from the front panel, providing automatic correction for further measurements.

1-12. SPECIFICATIONS

1-13. Mainframe specifications with DC Volts and DC Ratio measurement capability are presented in Table 1-3. Optional function specifications are supplied with the res-

pective option modules and included in Section 6. The table of specifications presented here is divided into two parts:

- 1. Accuracy
- 2. Instrument Operating Characteristics.

Table 1-2. 8500A/AE Accessories

Model or Part No.	Name
M04-205-600	Rack Ear Mounting Assembly
M00-260-610	18-inch Rack Slides
M00-280-610	24-inch Rack Slides
80F-5	High Voltage Probe
80F-15	High Voltage Probe
81RF	High Frequency Probe
82RF	High Frequency Probe
KDM1	Keyboard Display Module w/Cable
Y8001	IEEE Std. Cable, 1 Meter Length
Y8002	IEEE Std. Cable, 2 Meter Length
Y8003	IEEE Std. Cable, 4 Meter Length
MIS-7011K*	Extender Assembly
MIS-7191K*	Test Module
MIS-7013K*	Bus Interconnect and Monitor
*For use during service or repair	

Table 1-1. 8500A/AE Options

Option No.	Name	Notes
01	AC/DC Converter (Averaging)	1,3
02	Ohms Converter	
03	Current Shunts	3
04	Calibration Memory	
05	IEEE Standard 488-1975 Interface	2
06	Bit Serial Asynchronous Interface	2
07	Parallel Interface	2
08	Isolator	4
09	AC/DC Converter (True RMS)	1,3
1) Options 01 and 09 cannot be installed simultaneously.		
2) Only one of Options 05, 06, and 07 can be installed at any time.		
3) For the AC portion of Option 03 to operate, either Option 01 or 09 must be installed.		
4) Option 08 must be installed for remote operations.		

Table 1-3. Specifications

ACCURACY						
Note The stated accuracies are valid under the following environmental conditions. Temperature: 18°C to 28°C (Except 24 hour: 22°C to 24°C) Humidity: ≤75% Line Regulation: 90V to 110V, 103.5V to 126.5V, or 207V to 253V @ 45 to 66 Hz						
DC Volts	Normal Resolution (Not in CAL Mode)					
	Range	Full Scale	Resolution	Accuracy + (% of Input + Number of Digits)		
				24 Hours	90 Days	1 Year
	100 mV	312 mV	1 uV	0.002 + 4	0.003 + 5	0.005 + 8
	1 V	2.5 V	10 uV	0.001 + 1	0.002 + 1	0.004 + 1
	10 V	20 V	100 uV	0.001 or 1 *	0.001 + 1	0.002 + 1
	100 V	160 V	1 mV	0.001 + 1	0.002 + 1	0.004 + 1
	1000 V	1200 V	10 mV	0.001 + 1	0.002 + 1	0.004 + 1
*Whichever is greater.						

Table 1-3. Specifications (cont)

ACCURACY (Continued)												
DC Volts (Continued)	High Resolution (In CAL Mode)											
	Range	Full Scale	Resolution	Accuracy ± (% of Input + Number of Digits)								
				24 Hours	90 Days	1 Year						
	1 V	2.5 V	1 uV	0.001 + 6	0.002 + 8	0.004 + 9						
	10 V	20 V	10 uV	0.001 or 6*	0.001 + 8	0.002 + 9						
100 V	160 V	100 uV	0.001 + 6	0.002 + 8	0.004 + 9							
1000 V	1200 V	1 mV	0.001 + 6	0.002 + 8	0.004 + 9							
	*Whichever is less.											
DC Ratio	<table><tr><th>Ext. Ref. Voltage</th><th>Accuracy</th></tr><tr><td>+20V to +40V</td><td>±(A + B + 10 ppm)</td></tr><tr><td>±V_{min}* to +20V</td><td>±(A + B + $\frac{200 \text{ ppm}}{ V_{\text{xref}} }$)</td></tr></table>		Ext. Ref. Voltage	Accuracy	+20V to +40V	±(A + B + 10 ppm)	±V _{min} * to +20V	±(A + B + $\frac{200 \text{ ppm}}{ V_{\text{xref}} }$)	A = 10V dc Range Accuracy B = Input Signal Function and Range Accuracy V_{min} = Minimum Allowable External Reference Voltage V_{xref} = Absolute Value of External Reference Voltage			
	Ext. Ref. Voltage	Accuracy										
	+20V to +40V	±(A + B + 10 ppm)										
	±V _{min} * to +20V	±(A + B + $\frac{200 \text{ ppm}}{ V_{\text{xref}} }$)										
	*The formula for determining V _{min} is included in Instrument Operating Characteristics											
	Example Calculations for External Reference Accuracy:											
	1. Input = + 90.000V, Ext. Ref. Input = 30.000V (+ 15V to Ext. Ref. HI, -15V to Ext. Ref. LO)											
	A = .001% + 1 Digit B = .001% + 1 Digit											
	Ratio Accuracy = ±(A + B + 10 ppm) = ±(.001% + 1 Digit + .001% + 1 Digit + .001% = ±(.003% + 2 Digits)											
	Reading may be between 3.0003 and 2.9997											
2. Input = 1.20000V, Ext. Ref. Input = .12000 (V _{min} for 1V Range)												
A = .001% + 1 Digit, B = .001% + 1 Digit, $\frac{200 \text{ ppm}}{V_{\text{xref}}} = \frac{.02\%}{.12} = .1667\%$												
Ratio Accuracy = ±.001% + 1 Digit + .001% + 1 Digit + .1667% = ±(.1687% + 2 Digits)												
Reading may be between .998313 and 1.001686.												
INSTRUMENT OPERATING CHARACTERISTICS												
DC Volts	TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C)			INPUT IMPEDANCE								
	Range	Temperature Coefficient		Range	Input Impedance							
	100 mV	± (3 ppm/reading + 0.5 digit)/°C		100 mV	> 10,000 MΩ							
	1 V	± (3 ppm/reading + 0.1 digit)/°C		1 V	> 10,000 MΩ							
	10 V	± (2 ppm/reading + 0.05 digit)/°C*		10 V	> 10,000 MΩ							
	100 V	± (3 ppm/reading + 0.1 digit)/°C*		100 V	10 MΩ							
	1000 V	± (3 ppm/reading + 0.05 digit)/°C*		1000 V	10 MΩ							
	*For High Resolution Multiply Digits by 10.			Guard to Chassis	5.6 MΩ							
	INPUT BIAS CURRENT											
	Bias Current	At time of Cal ≤ ± 5 pA	30 Days (23°C ± 1°C) ≤ ± 50 pA	Temperature Coefficient ± 3 pA/°C								

Table 1-3. Specifications (cont)

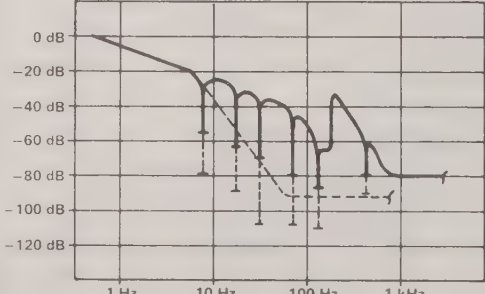
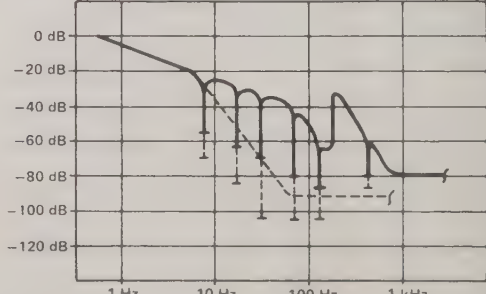
INSTRUMENT OPERATING CHARACTERISTICS (Continued)							
DC Volts (Continued)	RESPONSE TIME						
	Digitizing Time			Analog Settling Time Within Voltmeter			
	Mode of Operation	Reading Rate	Digitizing Time	Filter Mode	Step Input to 0.01% of Change	Step Input to 0.001% of Change	
	Bench	50 Hz line 6-1/4 rdg/sec	162 ms	Bypassed Filter <100k Source Resistance (Remote)	2 ms	20 ms	
		1-1/2 rdg/sec	642 ms				
	Remote	60 Hz line 7-1/2 rdg/sec	136 ms	Filter, Fast Filter, Slow (Manual)	40 ms 400 ms	50 ms 500 ms	
		1-7/8 rdg/sec	546 ms				
	50 Hz 4 samples/rdg*	22 ms					
	60 Hz 4 samples/rdg*	18 ms					
*Number of samples per reading is remotely programmable from 1 (2 ⁰) to 131,072 (2 ¹⁷) in 18 binary steps.							
ZERO STABILITY				OVERLOAD			
Better than 5 μV for 90 days after a one hr. warm-up. Front Panel pushbutton auto zero is provided. The zero correction is stored in memory until power is interrupted or the 8500A/AE is RESET. If calibration memory Option -04 is installed, the zero correction is retained.				± 1200V DC to 60 Hz, or 1400V peak AC above 60 Hz may be applied continuously to any dc range without permanent damage. Maximum common mode rate of voltage rise is 1000V/μsec.			
NOISE REJECTION							
Normal Mode						Common Mode	
Line/Filter Frequency	4 Samples/Rdg*	7-1/2 rdg/s	6-1/4 rdg/s	1-7/8 rdg/s	1-1/2 rdg/s	True	Effective
50 Hz Fast Filter	60 dB	N/A	70 dB	N/A	75 dB	100 dB at 60 Hz for 1 KΩ unbalance	Sum of Common Mode Rejection and Normal Mode Rejection
50 Hz Slow Filter	85 dB	N/A	90 dB	N/A	95 dB		
60 Hz Fast Filter	60 dB	70 dB	N/A	75 dB	N/A		
60 Hz Slow Filter	90 dB	95 dB	N/A	100 dB	N/A		
*Remotely selected							
1-7/8 Readings/Second Typical Performance with 60 Hz Line				1-1/2 Readings/Second Typical Performance with 50 Hz Line			
							
Cusps shown are at multiples of 60 Hz line frequency				Cusps shown are at multiples of 50 Hz line frequency			

Table 1-3. Specifications (cont)

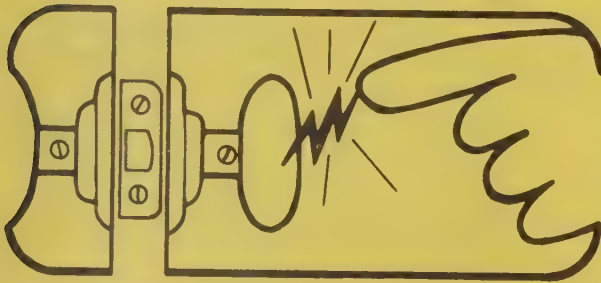
INSTRUMENT OPERATING CHARACTERISTICS (Continued)						
DC Ratio	INPUT IMPEDANCE		SOURCE IMPEDANCE			
	Ext Ref HI or LO X 10,000 MΩ relative to Ohms Guard* or Sense LO		Resistive Unbalance (Ext Ref HI to LO) <4 kΩ Total Resistance Sense LO from either HI or LO <20 kΩ			
	BIAS CURRENT		OVERLOAD (Ext Ref HI or LO)			
	Ext Ref HI or LO relative to Ohms Guard* or Sense LO <5 nA		±180 volts peak , 127V rms (relative to Ohms Guard* or Sense LO) X (360V peak HI to LO)			
	*Ohms Guard available through rear input					
	NOISE REJECTION					
	Normal Mode		Common Mode, All Inputs Driven			
	Sense Input—Same as dc volts		Sense Input—Same as dc volts			
	Ext Ref Input—dc, line frequency and 2x line frequency >100 dB		Ext Ref Input—Line frequency and 2x line frequency, 75 dB			
	RESPONSE TIME					
	Settling Time		Sense Input			
	Sense Input Fast Filter < 50 ms to 0.001% of change Sense Input Slow Filter <500 ms to 0.001% of change		Mode of Operation	Line Volt	Approx. Rdg. Rate	Digitizing Time
	Digitizing Time		Bench	60 Hz	4½ rdg/s 1½ rdg/s	136 ms 536 ms
	NOTE The Sense Input is measured prior to measuring Ext Ref HI and LO.			50 Hz	3½ rdg/s 1¼ rdg/s	162 ms 642 ms
	Ext Ref Input—Each input HI and LO		Remote	60 Hz	4 samples/rdg	18 ms
90 ms at 60 Hz line frequency 107 ms at 50 Hz line frequency		50 Hz		4 samples/rdg	22 ms	
Ext Ref Calibration—12 ms						
EXT REF VOLTAGE RANGE						
Maximum Ext Ref Voltage = ±40V between Ext Ref HI and LO terminals, providing neither terminal is greater than ±20V relative to the Sense LO or Ohms Guard terminals.						
Minimum Ext Ref Voltage = ±0.0001V, or $\frac{ V_{\text{input}} }{\text{Maximum Display within Range}}$ (whichever is greater) (See Table Below)						
MAXIMUM DISPLAY—(Ratio/Scaling)						
AC & DC VOLTS		AC & DC CURRENT		OHMS		
Range	Maximum Display (V/V)	Range	Maximum Display (A/V)	Range	Maximum Display (Ω/V)	
100 mV	± 999.999 X 10 ⁻³	100 uA	± 999.999 X 10 ⁻⁶	10 Ω	± 99.9999	
1 V	± 9.9999	1 mA	± 9.99999 X 10 ⁻³	100 Ω	± 999.999	
10 V	± 99.9999	10 mA	± 99.9999 X 10 ⁻³	1 kΩ	± 9.99999 X 10 ³	
100 V	± 999.999	100 mA	± 999.999 X 10 ⁻³	10 kΩ	± 99.9999 X 10 ³	
1000 V	± 1279.99	1 A	± 1.2799	100 kΩ	± 999.999 X 10 ³	
				1 MΩ	± 9.99999 X 10 ⁶	
				10 MΩ	± 99.9999 X 10 ⁶	
				100 MΩ	± 999.999 X 10 ⁶	



static awareness



A Message From
John Fluke Mfg. Co., Inc.



Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

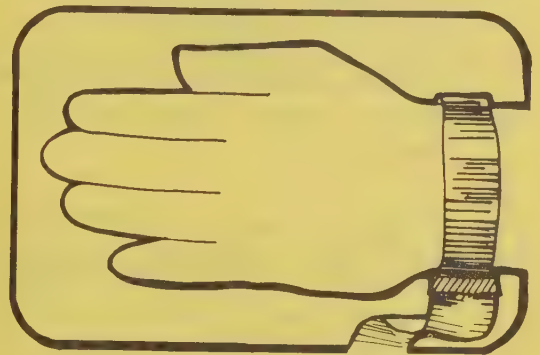
The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol



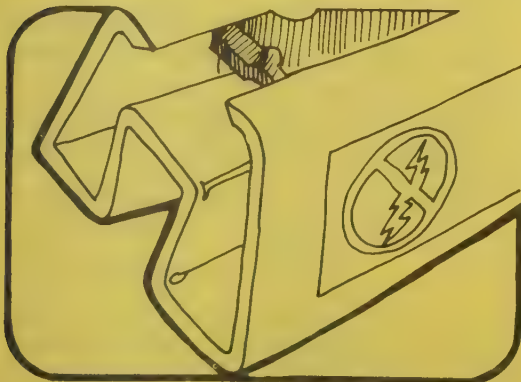
The following practices should be followed to minimize damage to S.S. devices.



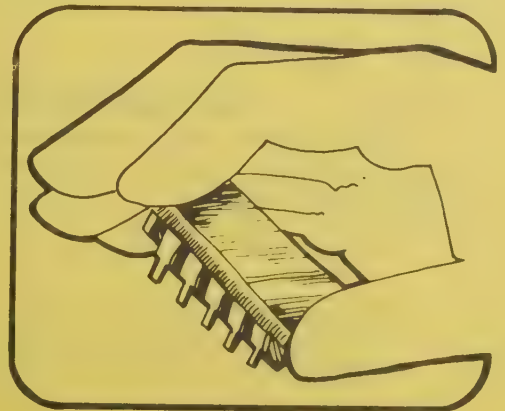
1. MINIMIZE HANDLING



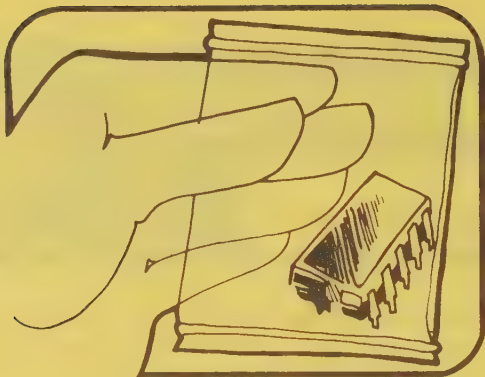
3. DISCHARGE PERSONAL STATIC
BEFORE HANDLING DEVICES



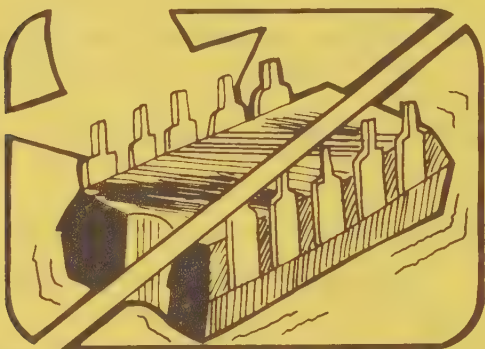
2. KEEP PARTS IN ORIGINAL CONTAINERS
UNTIL READY FOR USE.



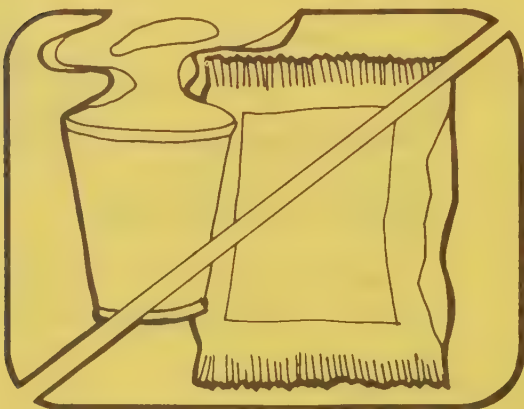
4. HANDLE S.S. DEVICES BY THE BODY



5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT

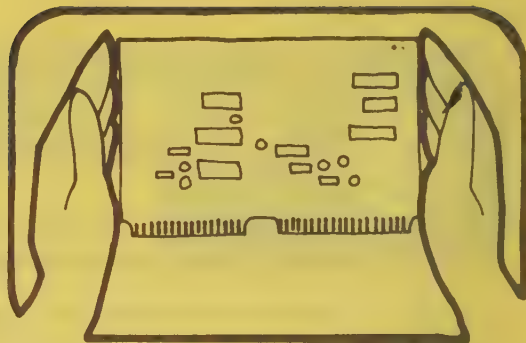


6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE

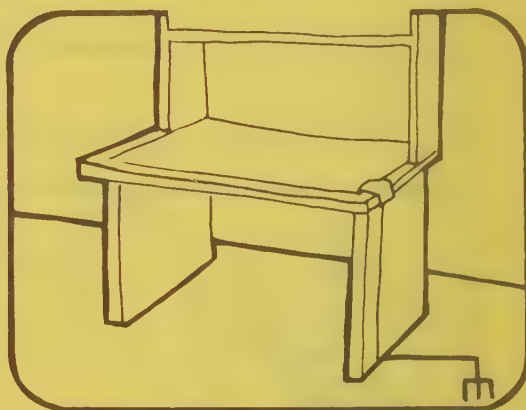


7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA

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AND GENERAL DYNAMICS, POMONA DIV.



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR USUALLY PROVIDES COMPLETE PROTECTION TO INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION
10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.
11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Description
680892	5" x 8" Bag
680934	8" x 10" Bag
680942	8" x 12" Bag
680983	12" x 16" Bag
681023	18" x 18" Bag

Pink Poly Sheet	Wrist Strap
30" x 60" x 60 Mil	P/N TL6-60
P/N RC-AS-1200	\$7.00
\$20.00	

Section 2

Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information regarding installation and operation of the Model 8500A/AE Digital Multimeter. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, contact your nearest John Fluke Sales Representative or the John Fluke Mfg. Co., Inc.; P. O. Box 43210; Mountlake Terrace, WA 98043; telephone (206) 774-2211. A list of Sales Representatives is located in Section 7 of this manual.

2-3. SHIPPING INFORMATION

2-4. The 8500A/AE is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included with the shipping container.

2-5. If reshipment is necessary, the original container should be used. If the original container is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INSTALLATION

2-7. Non-marring feet and a tilt-down bail are installed on the instrument for field or bench use. A rack-mounting kit and rack slides are available for use with standard 19-inch equipment racks. Information regarding installation of rack-mounting accessories is contained in Section 6.

2-8. Input Power Requirements

2-9. The 8500A/AE operates from either 115V ac $\pm 10\%$ or 230V ac $\pm 10\%$, 50 or 60 Hz (103.5 to 126.5V ac, or 207 to 253V ac, 45 to 66 Hz). The line voltage that the 8500A/AE is operated from must be within the specified tolerance. A binding post on the rear panel has been provided to assure

a proper earth ground connection. Section 4 contains instructions for switching the power supply from accepting 115V ac to 230V ac or vice versa. Operation at 50 Hz is the same as at 60 Hz except for slower response times.

CAUTION

Unless the chassis of the 8500A/AE is properly grounded, the possibility of electrical shock may occur when measuring high ac voltage with the leads reversed (Input HI grounded). The ground connection has been provided in the three-prong connector.

2-10. Fuses

2-11. The 8500A/AE contains three easily replaceable fuses. The line fuse ($\frac{1}{2}$ A MDL Slow Blow) is located on the rear panel near the heatsink. Two identical current protection fuses (AGC $1\frac{1}{2}$ A) are found in the front lower right corner and above the rear input connector.

2-12. OPERATING FEATURES

2-13. The location and function of all 8500A/AE controls, indicators, and connectors are shown in Figure 2-1 and described in Table 2-1.

2-14. OPERATING NOTES

2-15. General

2-16. Although itself complex, the 8500A/AE is relatively simple to use. Its operation can best be understood when considered within the following categories:

1. Front panel programming
2. Display information.
3. Front panel analog inputs.
4. Rear panel (Remote) analog inputs.

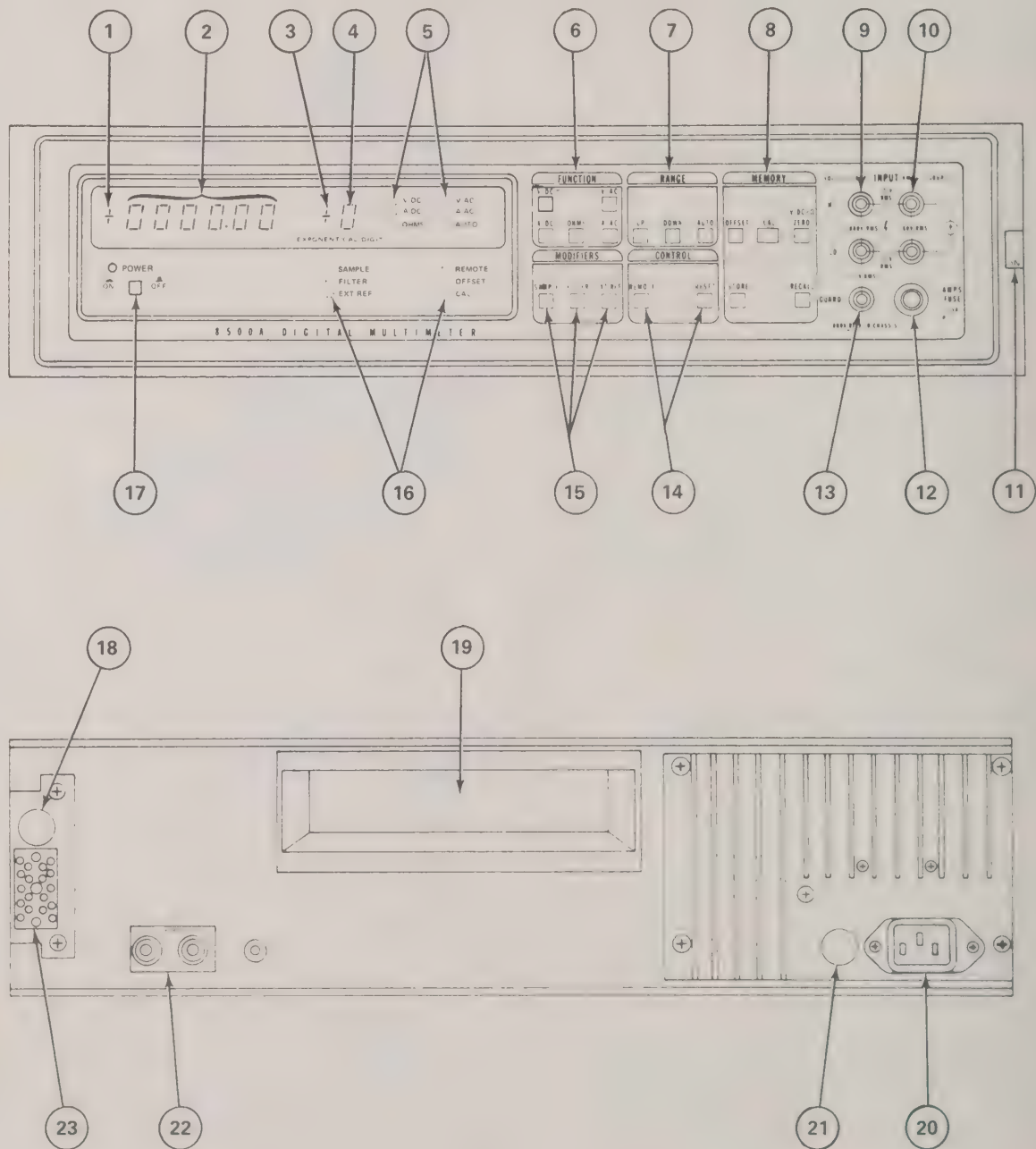


Figure 2-1. 8500A/AE Controls, Indicators and Connectors

Table 2-1. 8500A/AE Controls, Indicators and Connectors

REF. NO.	NAME	FUNCTION
1	Polarity Display	Displays polarity of readings when appropriate
2	Digit Display	Displays value of reading with properly positioned decimal
3	Exponent Polarity	Shows polarity of exponent for engineering notation.
4	Exponent Display	Displays exponent for engineering notation
5	Range and Function Indicators	LEDs illuminate to indicate function selected and whether or not in autorange
6	Function Switches	Selects function—DC Volts, AC Volts, DC and AC Volts, DC Current, AC Current, and Ohms. Optional modules must be installed for other than DC volts. Error 9 will be displayed if a function is selected for which the module is not installed
7	Range Switches	UP and DOWN change the range one range at a time, AUTO selects or disables autoranging
8	Memory Switches	OFFSET, VDC/ Ω ZERO, STORE, and CAL are used to place values into memory for computations. ZERO and CAL factors are applied automatically. OFFSET function must be selected separately from entering a value into memory. CAL may be used to obtain an extra digit of resolution in all but the lowest range. RECALL is used to display a previously entered CAL, OFFSET, or DC ZERO factor.
9	Input VOLTS/ Ω Sense Terminals	HI and LO connections for DC and AC voltages and Ohms measurements
10	Input AMPS/ Ω Source Terminals	HI and LO connections for Current and Ohms measurements
11	Rear Input In	Push in to connect rear terminals, disconnect front terminals
12	Current Fuse	Use a 1½ Amp Fast Blow Fuse (ohms, Source, Front Inputs)
13	Guard Terminal	For guarded measurements (should always be connected)
14	Control Switches	REMOTE toggles control from front panel to remote; selecting remote disables all front panel switches except REAR IN, POWER and REMOTE. RESET initiates a master program restart (to the beginning).
15	Modifier Switches	Selects samples/rdg rate, filter (fast or slow) and external reference
16	Status Indicators	LED's illuminate to indicate status of remote control, offset and cal memory, filter and ext ref modifiers. Sample LED will flash at the sample rate selected.

Table 2-1. 8500A/AE Controls, Indicators and Connectors (cont)

REF. NO.	NAME	FUNCTION
17	Power Switch	Push on/Push off for line power
18	Current Fuse	Use a 1½ Amp Fast Blow Fuse (Rear Input Ohms Source)
19	Interface Connector and Switches	Connector and address switches accessible in this area when a remote interface module is installed.
20	AC Line Voltage Connector	Three-prong connector accepting line cord with ground wire
21	Line Fuse	Use an MDL ½ (slo-blow)
22	Ext Ref Terminals	Input for external referencing. Disconnected when rear inputs used.
23	Rear Inputs	Source HI and LO, Sense HI and LO, Guard, OHMS GUARD, EXT REF HI and LO.

2-17. Upon applying power to the 8500A/AE, the display will read "HI" and the option configuration (Cxxxxx, where x is the installed option number). Unless the function and range are selected immediately, the instrument will place itself in DC volts function, 1000V range. Function and range can then be changed at any time. The 8500A/AE should be given a one hour warmup, to insure rated accuracy.

2-18. Front Panel Programming

2-19. With the exception of the Power, Cal, and Rear Input switches, all front panel switches are momentary contact. If such a switch is held in continuously, it will be "read" only one time.

2-20. FUNCTION

2-21. A function (AC V, DC V, etc.) may be selected by depressing the appropriate switch. DC volts is standard with the 8500A/AE; optional modules must be installed for DC current, ohms, AC volts or AC current. Section 6 of this manual will explain operations with any optional modules. If a function is selected for which the optional module is not installed, Error 9 will appear in the display.

2-22. RANGE

2-23. When a valid function has been selected, the 8500A/AE will automatically shift to autoranging. Manual ranging may be selected by depressing either the UP or the DOWN switch; the range will then change one for each depression in the desired direction. Autoranging may be regained by depressing the AUTO switch. Depressing the AUTO switch again will select manual ranging without changing the range.

2-24. MEMORY

2-25. Offset

2-26. In the offset mode, whatever value is entered in memory will be automatically subtracted from subsequent readings. The offset function cannot be selected in a range lower than the one in which an offset value was placed in memory. To enter an offset value into memory:

1. Apply desired input value to the Volt/ohm input terminals.
2. Depress the STORE switch. "?" will appear in the display.
3. Depress the OFFSET switch. The value applied to the input terminals will now be stored in memory.

2-27. Cal

2-28. The calibration mode can be used to add an extra digit of resolution to the display. This action cannot be done in the lowest range. Provided the optional calibration memory is installed, the cal mode also permits the entry of calibration factors for each function and range. The CAL switch is accessible behind a plastic cover (pops out, hinges down) on the front panel. To enter the cal mode, use a small screwdriver or equivalent to push the slide switch down. Note the following considerations when in the cal mode:

1. The instrument's exponent value display, now used as the extra digit, will be lost.
2. The Error Code function is disabled. The only indication of an invalid function will now be random readings.

3. If CAL mode is selected, and the Cal Memory optional module is installed, inadvertent use of the STORE switch will erase or alter the calibration factor for the function and range in use at the time.

2-29. VDC/Ohms Zero

2-30. The 8500A/AE employs digital zeroing. Separate zero values may be stored for the VDC function (and for the Ohms function when the Ohms converter, -02 option, is installed).

1. Place the instrument in its lowest range (100 mV or 10 ohms).
2. Place a good quality short between INPUT HI and LO terminals for VDC. For ohms shorting, consult Ohms Converter -02 option information.
3. Depress the STORE switch.
4. Depress the V DC/OHMS ZERO switch.

2-31. Recall

2-32. To recall and display a stored value:

1. Depress the RECALL switch.
2. Depress the switch for the desired stored value (Offset, Cal, or VDC/OHMS Zero). This value will be displayed as long as the related switch is held depressed. Note that ohms zero values cannot be recalled.
3. The instrument's range at the time the RECALL switch was used will determine the recalled value's resolution.

2-33. Store

2-34. Use the 8500A/AE's STORE switch to enter an offset, cal, or VDC/Ohms value in memory. Refer to related memory operation instructions.

2-35. CONTROL

2-36. Reset

2-37. Use of the RESET switch will start the main program over. Save for warmup time, the sequence mentioned in paragraph 2-17 will repeat.

2-38. Remote

2-39. Depressing the REMOTE switch places the 8500A/AE in remote control; only the POWER, REAR IN, or REMOTE switches will now have any local control of the instrument. Local control can be regained by depressing the REMOTE switch a second time or by momentarily inter-

rupting power. When in remote, the instrument can only be controlled through an optional remote interface module. Refer to Section 6 for use of the REMOTE switch with -05 option installed.

NOTE

"Remote control" of the 8500A/AE has nothing to do with providing connections to rear input terminals (HI, LO, GUARD, ETC.) These connections can only be made through local use of the REAR INPUT switch.

2-40. MODIFIERS

2-41. Ext. Ref.

2-42. An external reference can be applied by depressing the EXT REF switch. The value present at the ext. ref. terminals, which can only be a DC voltage, will then be seen in the display for as long as the switch is held in. EXT REF can be turned off by again depressing the switch.

2-43. An external reference dc voltage can be used to divide the inputs in any function. A true ratio measurement is then computed by the Controller.

$$\text{Reading} = \frac{\text{Input}}{\text{dc Ext. Ref. Input}}$$

A pair of external reference terminals, found either separately on the rear panel or together in the rear input connector, will accept only a dc voltage.

1. This voltage may be a maximum of $\pm 20\text{V}$ at either external reference HI or LO, with respect to sense LO (or to Ohms Guard in the rear input connector). A maximum of 40V may therefore be applied between external reference HI and LO.

2. The minimum voltage applicable to the external reference terminals is the greater of either $\pm 100 \mu\text{V}$, or a value found with the following formula:

$$V_{\min} = \frac{|V_{\text{in}}|}{\text{Maximum Display Within Range}}$$

A table of maximum displays for each range can be found under specifications in Section 1.

Example: Voltage applied to the Volt/ Ω terminals = -8.0000V ; Maximum Display Within 10V Range (ext ref mode) = ± 99.9999

$$V_{\min} = \frac{8.0000\text{V}}{99.9999} = .0800001\text{V}$$

A connection must be made from sense LO to either External Reference HI or LO having a total resistance of less than 20k ohms .

2-44. Two examples of accuracy determination have been included in the specifications in Section 1. These examples are of most use to a metrologist in that known inputs were used and allowable deviations were the results. The following is an example of determining a pure percentage (without $\pm$ digits) to be applied to unknown inputs.

Measured

Volt/ Ω input = 9.0000V

Measured

Ext. Ref. input = 2.0000V

$$\text{Accuracy} = \pm \left(A + B + \frac{200 \text{ ppm}}{|V_{xref}|} \right)$$

where A = 10V dc range accuracy

B = Input signal function and range accuracy

$|V_{xref}|$ = Absolute value of external reference input

$$A = .001\% + 1 \text{ digit} \quad \frac{200 \text{ ppm}}{V_{xref}} = \frac{.02\%}{2}$$

$$B = .001\% + 1 \text{ digit}$$

$$A \& B = .002\% + 2 \text{ digits}$$

$$\frac{200 \text{ ppm}}{|V_{xref}|} = .01\%$$

$$\text{Accuracy} = .012\% + 2 \text{ digits}$$

Translating digits to percentage:

$$\text{Ratio Reading} = \underline{4.5000}$$

Same number of digits behind decimal as in maximum range reading

$$2 \text{ digits is } .0044\% \text{ of } 4.5000 \quad \left(4.5 \sqrt{\frac{.000044}{.0002}} \right)$$

Accuracy expressed as a percentage = $\pm .0164\%$

2-45. Filter

2-46. Fast or slow filters can be selected with this switch. The slow filter, which is selected when the FILTER LED is illuminated, provides:

1. Faster roll-off below 60 Hz.
2. Better normal mode noise rejection at 60 Hz.

The fast filter provides:

1. Better discrimination against higher frequency and harmonically related line noise.
2. Better filtering where stepped input functions with faster settling times are required and where noise is not a problem.

2-47. Sample

••

2-48. Two sample rates can be selected by using the SAMPLE switch (128 samples/reading or 32 samples/reading). These yield reading rates of 1-7/8 or 7-1/2 per second respectively (at 60 Hz), and 1-1/2 or 6-1/4 per second (at 50 Hz). Since samples are taken synchronous to the line frequency and since line noise rejection increases with the number of samples averaged, the greatest line noise rejection will be found at the lower reading rate (1-7/8 or 1-1/2 per second).

2-49. Display

2-50. The 8500A/AE display section provides 5-1/2 digit readout, polarity and exponent indicators, and LED annunciators directly related to front panel switch positions described under 2-18.

1. Polarity Indicator.
2. 5-1/2 Digit Readout - automatic reading and decimal placement.
3. Exponent Indicator - automatically provides readings and polarity in engineering notation for volts, ohms and amps. May be used as extra digit of resolution in Cal mode.
4. Function annunciators - LED indication of function selected.
5. Auto annunciator - lights when autoranging in effect.
6. Memory annunciators - indication of CAL, and OFFSET selection.
7. Remote annunciator - lights when 8500A/AE is in remote control.
8. Modifier annunciators - indicate if slow filter or external ref. selected; flash at reading rate (sample).

2-51. The 5-1/2 digit display will provide additional warning, error and general information.

1. Upon application of power, "HI" and then the option configuration will appear. You will view "C", followed by the option number.
2. "HHHHHH" will flash at the sample rate if the input voltage exceeds the full scale value in the range selected. This indication will not be seen in the cal mode.
3. "H" will flash in the exponent display if an input voltage greater than 40 volts occurs in the external reference or offset mode. This warning will not be seen if the CAL switch is activated.

NOTE

Flashing indicators are a warning only; they have no effect on instrument operation.

4. Error codes provide much useful information. Error codes can be deciphered by using Table 2-2 or by using the pull out instruction tab under the 8500A/AE's right side.

NOTE

Error codes will not be displayed in CAL mode. Random reading will then be the only indication of an invalid function or faulty module.

Table 2-2. Error Codes

CODE	FAULT
Error	System error — if the error message appears prior to the introductory messages at power initialization or reset, the problem is with the calibration memory module.
Error 0	VDC/ Ω Zero Error — either a VDC/ Ω Zero was attempted in a range other than 100mV or 10 Ω , or an overrange value was entered.
Error 1	Offset error — either down ranging was attempted past the range of the offset, the offset was recalled in a different function than was stored, or it was toggled into offset in a function where an offset value was not stored.
Error 2	Filter Module error — the Module is faulty or not installed.
Error 3	DC Signal Conditioner error — the Module is faulty or not installed.
Error 4	Ohms or Current error — excessive voltage applied to the selected module, shorting links not properly connected, or the selected module is faulty.
Error 5	R ² A/D error — the recirculating remainder analog to digital converter module is faulty or not installed.
Error 6	Numeric display overflow error.
Error 7	External reference error — the magnitude of one of the ext ref inputs is greater than 20V dc.
Error 8	Controller error — the module is faulty or not installed.
Error 9	Function Selection error — the function module selected, other than dc volts, is faulty or not installed.

2-52. Front Input Terminal Use

2-53. The 8500A/AE measures dc volts in five ranges from 100 mV to 1000V. Resolutions from 1 μ V to 1 mV respectively are available. Further information on overrange capabilities, and overload protection can be found in Section 1 of this manual. Input impedance is 10 Mohms in the 100V and 1000V ranges and greater than 10,000 Mohms in the 100 mV, 1V, 10V ranges.

CAUTION

Do not ground the INPUT HI side and drive the LO; the input impedance would be reduced to 5.6 Mohms through the guard bleeder resistor.

2-54. For dc voltage measurements, both INPUT HI terminals may be left strapped together. The INPUT LO terminals may likewise remain strapped. And, for most measurements, it is sufficient to strap GUARD to INPUT LO.

2-55. Common mode voltages, resulting from currents and voltage drops between two points otherwise electrically common, may produce significant errors. Proper use of a floating, guarded voltmeter will minimize these errors and allow representative reading or normal mode voltages (actual source voltage and noise).

CAUTION

The guard terminal should not be left disconnected. Instrument damage can occur if common mode voltage exceeds the LO to guard maximum voltage rating (100V).

2-56. Correct use of the 8500A/AE's guard terminal will both protect the instrument and provide more accurate readings. Since the LO to guard maximum voltage rating of the 8500A/AE is 100V, the guard terminal should always be connected either to the input LO terminal or to a point in the source circuit to be measured. For accurate readings, connect the guard to minimize common mode currents flowing through any resistance which helps determine the voltage being measured. Various methods for doing this are shown in Figure 2-2.

2-57. Generally, guarding should be used in the following situations:

1. When long signal leads are used.
2. When signal source impedance is high.

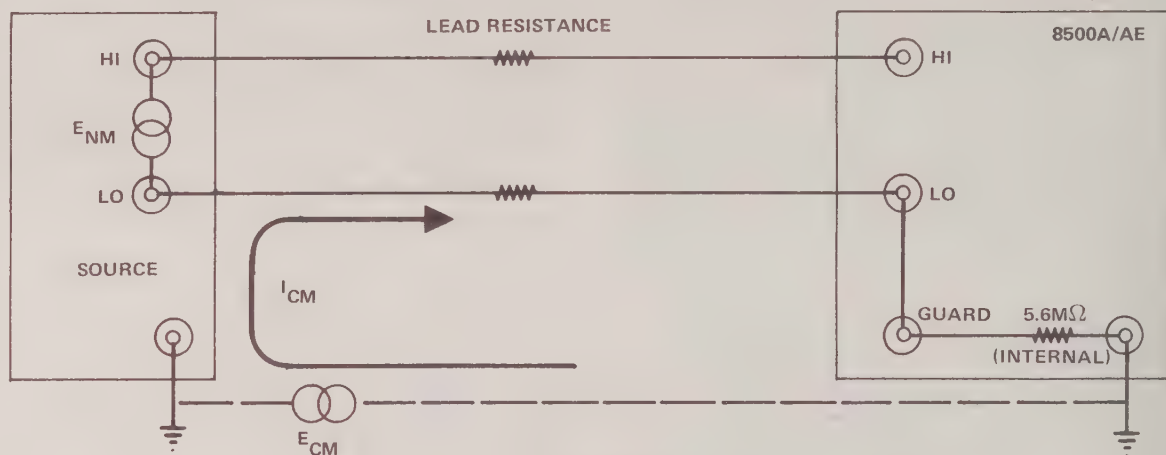
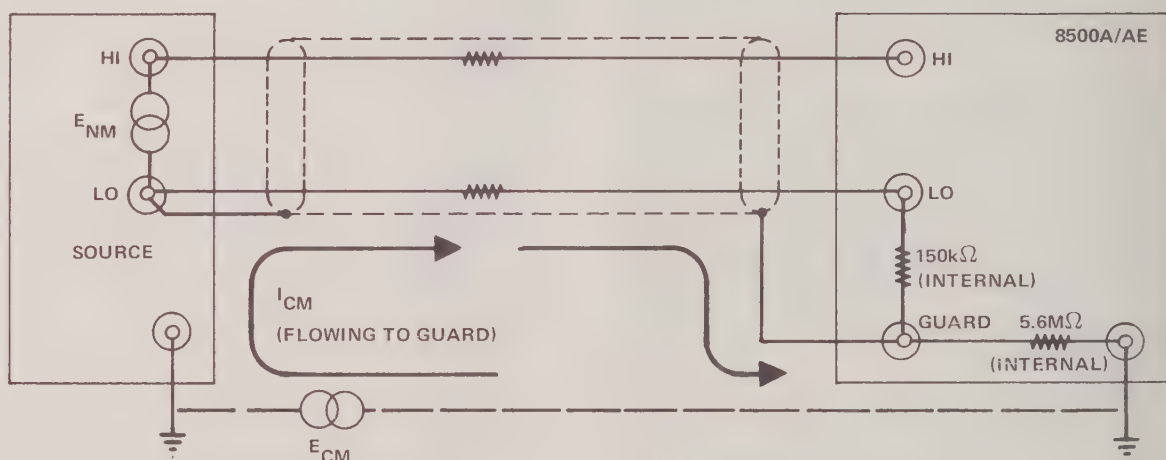
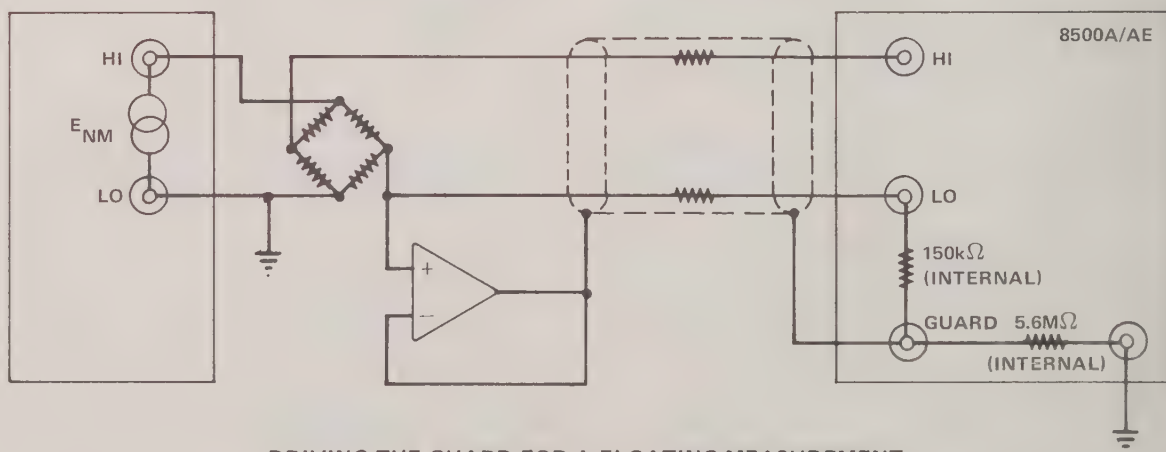
FOR NONCRITICAL MEASUREMENTS – E_{CM} ERROR PRESENT E_{CM} ERROR MINIMIZED – I_{CM} FLOWS THROUGH SHIELD INSTEAD OF THROUGH TEST LEADSDRIVING THE GUARD FOR A FLOATING MEASUREMENT
WHICH MAY BE LOADED BY DIRECT CONNECTION OF THE GUARD

Figure 2-2. Guard Connections

3. When making measurements near high-level radiated noise, particularly at the power line frequency.
4. When making floating measurements.

NOTE

Errors due to thermal EMF's should be considered when making low level, high resolution measurements. Thermal EMF's (voltages produced by temperature differences between contacts of two dissimilar metals or by temperature gradients along a length of material) may cause differences in potential of several microvolts. Since the 8500A/AE utilizes gold-plated input terminals, the use of low EMF, shielded cables with gold-plated spade lugs will minimize thermal EMF errors.

2-58. Rear Input Use

2-59. With the rear input switch (No. 11, Fig. 2-1) pushed in, all front panel inputs are disconnected. Samplings are now taken through the rear input connector. Since front panel terminal strapping is now irrelevant, the same precautions for guarding, and for other terminal interconnects,

must be observed remotely. In addition, external reference inputs are disconnected and must instead be applied through the rear input connector.

CAUTION

A difference in potential between front and rear input terminals of 1000V peak must not be exceeded. Damage to the front-rear switch could otherwise result.

2-60. Unlike the front inputs, the rear input connector offers an ohms guard. Use of the ohms guard is detailed in the Ohms Converter (Option 02) instructions (Section 6).

2-61. Systems Use of the 8500A/AE

2-62. By employing any one of three remote interfaces (optional modules), you can use the 8500A/AE with a large variety of digital systems. Operating and programming instructions related to remote operation are included with the appropriate optional module. Overall information on remote interfacing can be found in Fluke Application Bulletin 25 - "System Use of the Fluke Model 8500A." Specific information about the IEEE interface (-05 option) may be found in Fluke Application Bulletin 36.

Section 3

Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual describes the theory of operation for the 8500A/AE mainframe, which includes the modules necessary for DC Volts and DC Ratio measurements. Block Diagram Description gives an overview of the operation of the modules and an explanation of the bus structure. Circuit Analysis gives a more detailed description of the circuitry. Optional modules are described in Sect. 6.

3-3. BLOCK DIAGRAM DESCRIPTION

3-4. Bus Structure

3-5. The 8500A/AE is constructed with a bus architecture similar to a computer. Figure 3-1 is an overall block

diagram of the instrument with optional modules drawn in dashed lines. Figure 3-2 is a block diagram illustrating signal flow. A microprocessor-based controller module controls information flow on the three buses. The controller sets up each of the analog modules for a measurement by addressing the modules as memory locations. An unguarded digital interbus is used to connect the controller to the front panel and to digital option modules such as the calibration memory and a remote I/O (input/output) interface.

3-6. The unguarded digital interbus consists of seven control/address (IC) lines, eight bidirectional data (ID) lines, seven real time (RT) lines, three handshake (INT-interrupt, ACK-acknowledge, INA-interrupt acknowledge) lines, and power supply lines.

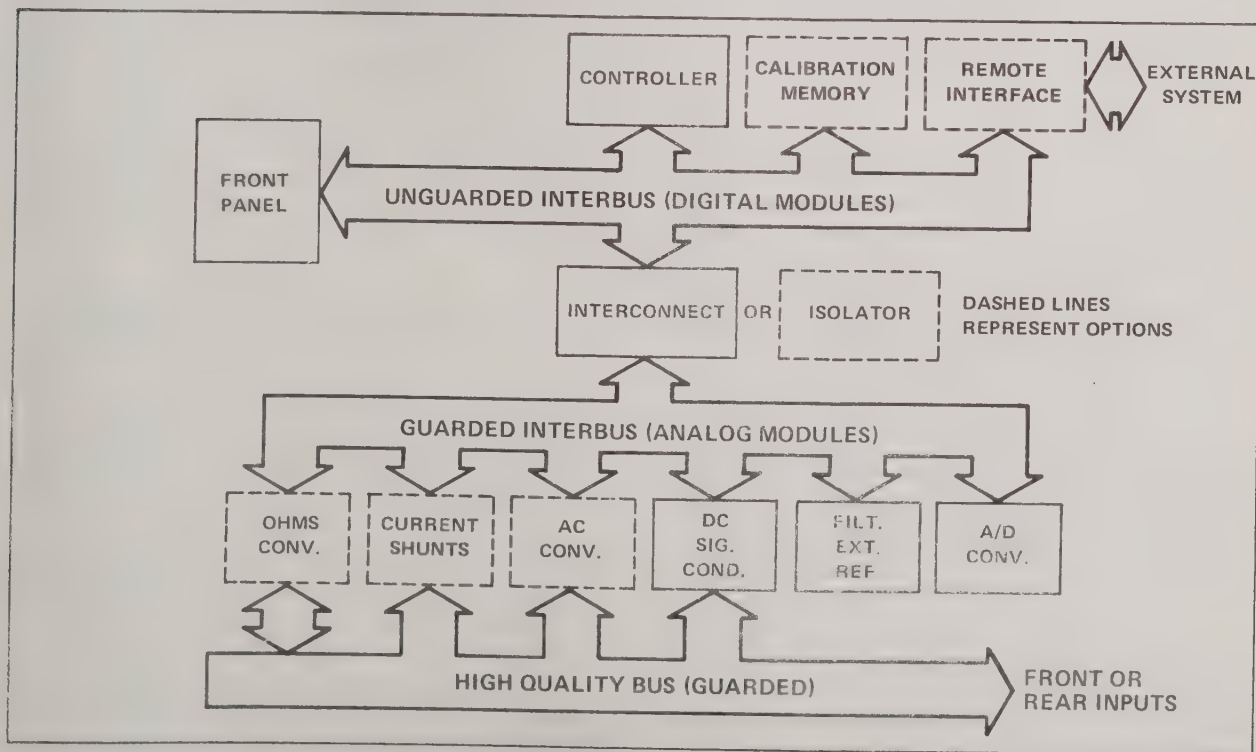


Figure 3-1. 8500A/AE Block Diagram

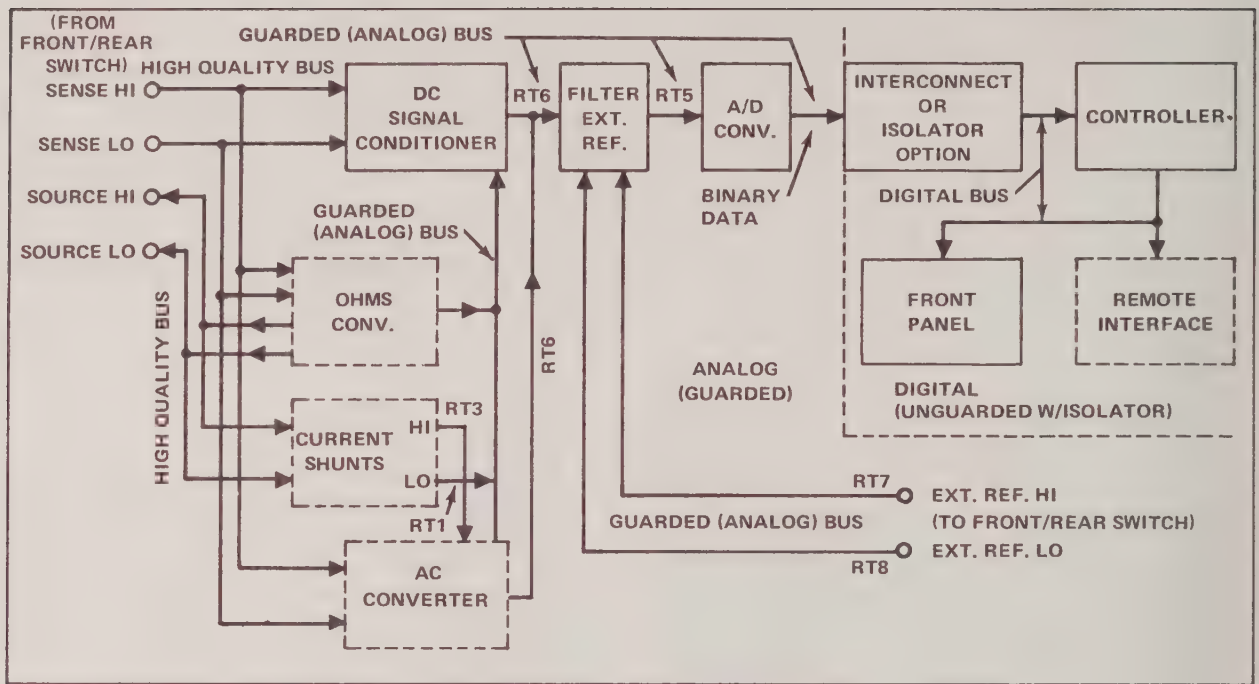


Figure 3-2. 8500A/AE Analog Signal Flow

3-7. A guarded bus connects the controller to the analog modules through an interconnect pcb or through an optional isolator module (must replace the interconnect pcb if an optional remote interface is installed). The guarded bus consists of seven control/address (IC) lines, eight bidirectional data (ID) lines, nine real time (RT) lines, one handshake (ACK) line, and power supply lines.

3-8. The address, handshake, and data lines of the two buses serve the same functions. The real time and power supply lines may have differing functions. For example, the RT lines in the unguarded bus are unused except for RT5 which is the line frequency reference. The RT lines in the guarded bus form an analog bus which carry all the conditioned and converted analog signals between the analog modules. The external reference input lines are part of the analog bus (RT7 and RT8). Logic supply lines (V_{cc} and V_{ss}) will be different in the two busses if an isolator option is installed. In the guarded bus, V_{cc} and V_{ss} are always $-15V$ and $-20V$ with respect to analog common. In the unguarded bus with an interconnect pcb installed V_{cc} and V_{ss} are diode coupled to the guarded bus. But with the isolator option installed, V_{cc} and V_{ss} are isolated from analog common.

3-9. The high quality bus consists of lines connecting the input switch (Sense HI and LO, source HI and LO, Guard, Ohms Guard) to the signal conditioning and converting modules (AC converters, Ohms converter, etc.). Ohms guard is only available through the rear inputs.

3-10. Controller

3-11. Under the direction of the software program, the controller addresses and sets up each of the modules necessary to perform a function. Two types of addresses are used: direct and indirect. An indirect address requires a previous direct address to set up the indirect address response logic. Data transfers are accomplished with a handshake between the address (IC) lines and the acknowledge (ACK) line. When the controller addresses a module, it places data on the data (ID) lines or receives data from the addressed module. The addressed module must respond with an ACK signal signifying that it is receiving or sending data.

3-12. The controller directs the R^2 A/D converter in taking a sample and receives the sample data from the converter. Range and function information is stored by the controller for application to the data. Using the arithmetic capability of the microprocessor, the software processes the data to arrive at a binary 2's complement number which represents the polarity and value of the measurement. This number is made available to an optional remote interface either as is or after further processing to ASCII code. The number is further processed by the controller for application to the front panel display in a seven segment LED format.

3-13. The software program consists of two parallel processes. A background process (Figure 3-3) is responsible for interrupt driven activities such as updating the display digits and directing the A/D converter in taking a sample.

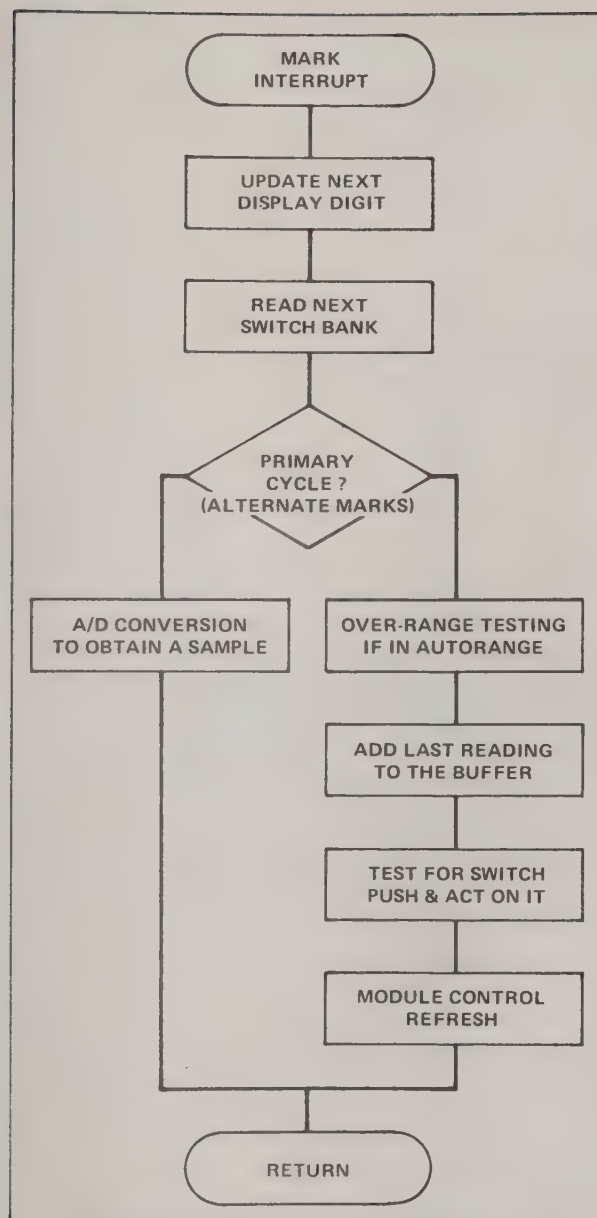


Figure 3-3. Background Software Process

The foreground process (Figure 3-4) is responsible for the measurement cycle including accumulating data from the background process and performing required calculations.

3-14. The controller is structured around the Intel 8080 microprocessor. Figure 3-5 is a block diagram of the controller module. Hardware control functions have been minimized by careful software design. Sequences of events are timed from two sources. Basic operations of the microprocessor are run from a 1.7 MHz clock. The other source is generated by shaped line frequency pulses, which are applied to a phase-locked loop. The phase-locked loop

multiplies the line frequency by eight. This signal is used to generate mark interrupts which time the background process.

3-15. Software for the 8500A/AE is stored in four ROMs (read only memory). Four RAMs (random access memory) are used for temporary storage of data by the microprocessor. Data lines (DB0-DB7) are used for bidirectional data flow. Address lines (A0-A15) determine the source or storage location of data. Since other modules of the 8500A/AE system are addressed as memory locations, address and data I/O controls are used for access to the external bus structure.

3-16. Interrupts are used to divert the microprocessor from the main program to service other routines. Interrupts are synchronized to an appropriate time in the microprocessor cycle through interrupt control, where assigned priorities vector module identity data onto the data bus. Module identity data words direct the microprocessor to the memory location containing the next instruction. Two interrupts are internally generated: ACK INT and MARK INT (priorities one and six respectively). ACK INT is generated when an acknowledge signal is not returned. MARK INT is used to synchronize A/D samples and display digit updates to the line frequency.

3-17. An interrupt may be externally requested by pulling the INT line low. When the microprocessor is ready to accept the interrupt, the interrupt acknowledge (INA) signal is generated. The requesting module must respond with an ACK and a data bit (on ID1-ID4) which is used as a priority vector by INT CONTROL.

3-18. Two types of resets may occur: software and hardware. Software resets are a result of front panel or remote requests. Hardware resets occur at power up or power down. Line frequency pulses from RT5 are sensed by the reset logic. At power up the reset signal assures that the microprocessor will start from program location zero. At power down the reset signal assures that the controller will not call up wrong modules.

3-19. The microprocessor control logic is responsible for latching up a status word at the beginning of each instruction cycle and for telling the microprocessor when to enter and exit wait states. Microprocessor sequences are divided into machine states (one clock period, 588 nsec), machine cycles (from three to five states) and instruction cycles (from one to five machine cycles). Status words are used to control and synchronize data I/O, memory read/write, and some of the interrupt control signals. The microprocessor must be instructed to enter a wait state after addressing an external module and after being interrupted to allow the external module time to respond.

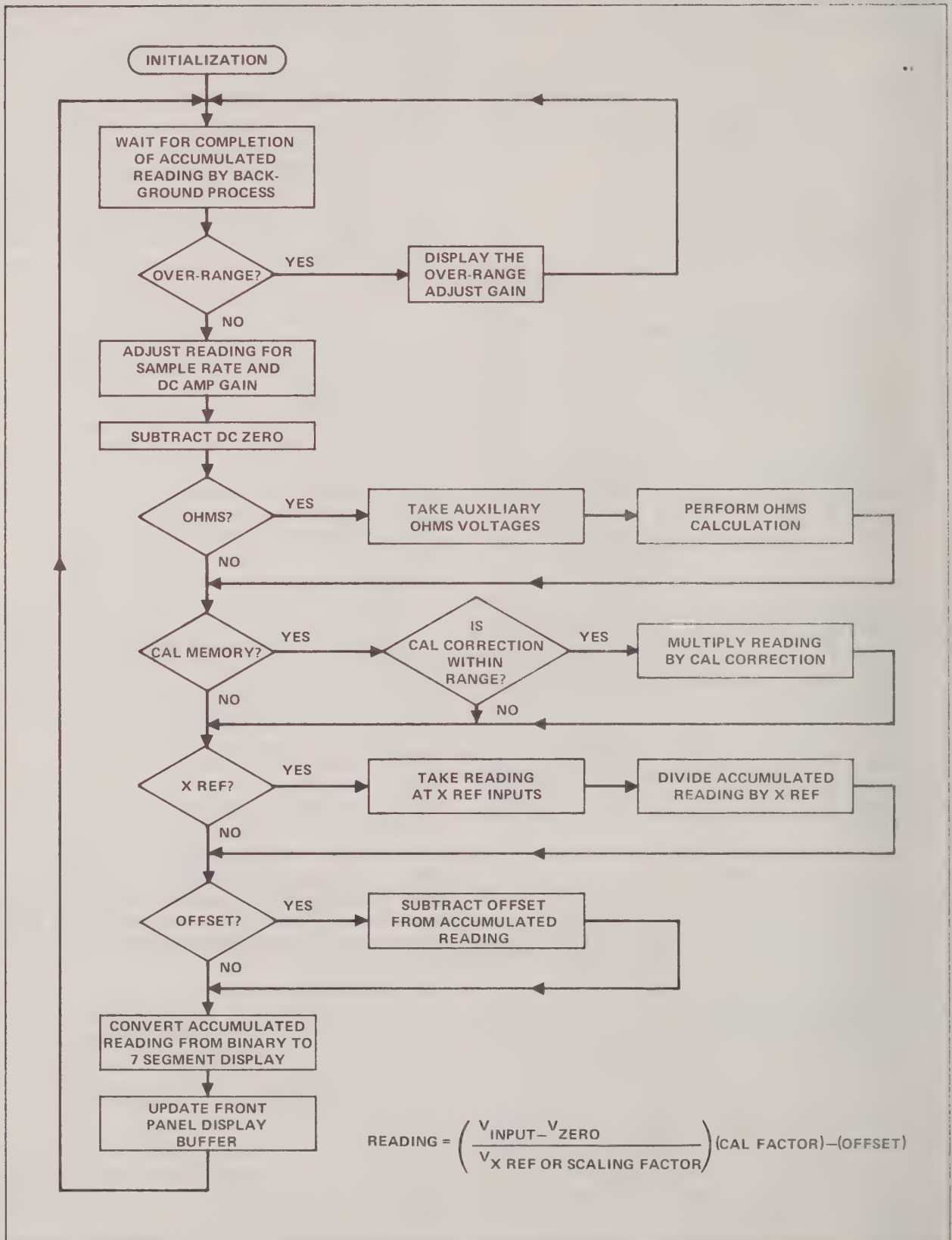


Figure 3-4. Foreground Software Process

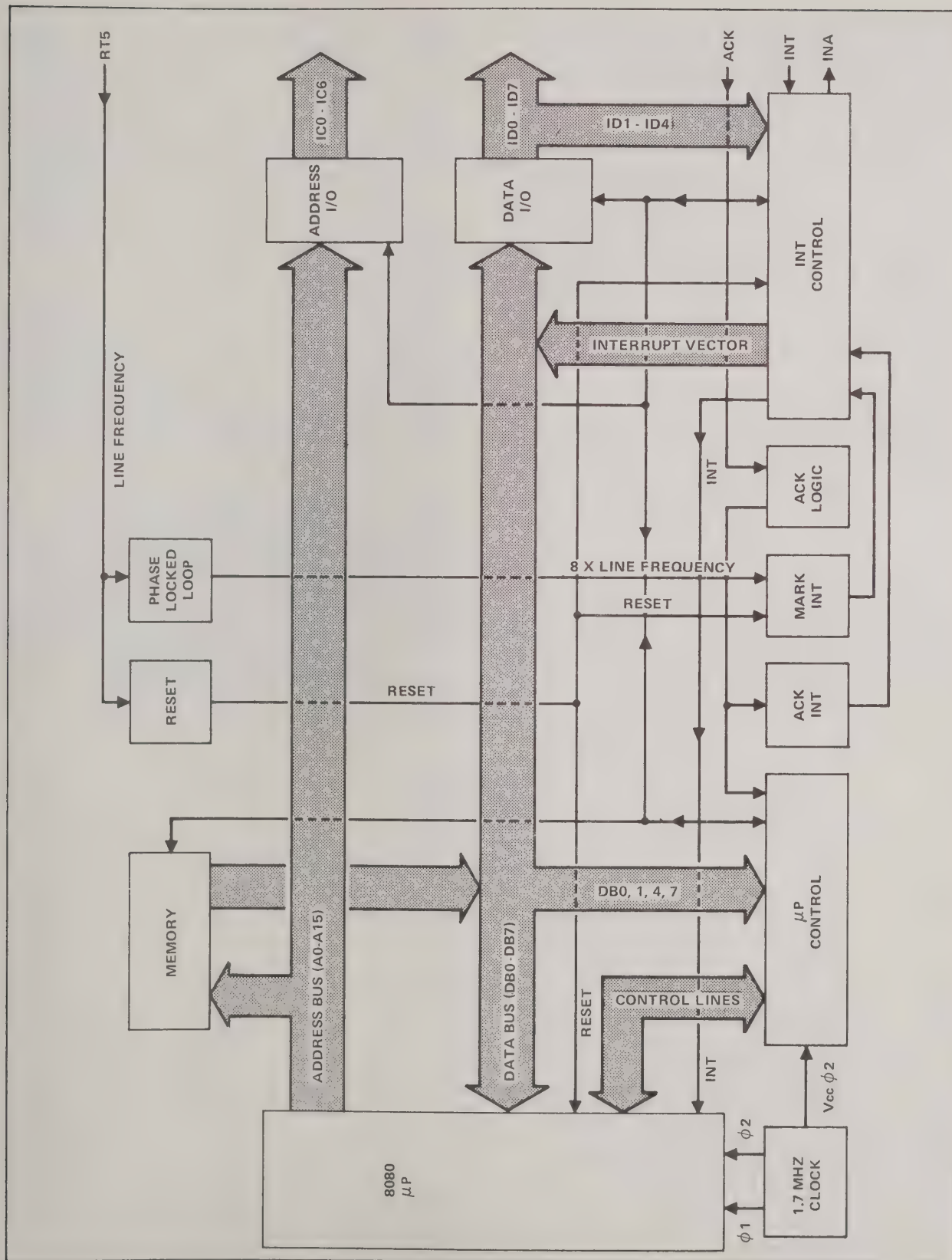


Figure 3-5. Controller Block Diagram

3-20. Front Panel

3-21. The front panel serves as an interface between the operator and the 8500A/AE controller. The display is multiplexed by the controller by means of addressing the front panel for each digit. One direct address, two indirect addresses, and the accompanying data determine which digit or annunciator and which segments will light. An indirect address requires a previous, valid direct address to set up the indirect response. Another direct address enables the switch matrix to be read to determine if any function changes are desired. The cycle of updating each digit and annunciator and reading the switch matrix requires approximately 14 msec and is a continual cycle. Input terminals, J1–J5, are physically located on the front panel but have no electrical interaction with the front panel.

3-22. DC Signal Conditioner

3-23. DC signals from either the input terminals or optional signal conditioners (Ohms or Current Shunts)

are routed through the DC Signal Conditioner to be brought within the range of the A/D Converter ($\pm 20V$). Figure 3-6 is a block diagram of the DC Signal Conditioner. For ease in arithmetic manipulations in the microprocessor, all gains or attenuations in the 8500A/AE are powers of eight. Gain or attenuation factors are selected by the microprocessor addressing the module. Data from the data bus is latched into the control circuitry and used to select relays in the attenuator and switches in the amplifier feedback circuit. The combination of the attenuator and feedback-controlled amplifier give gain or attenuation factors of one, eight, or sixty-four.

3-24. Active Filter

3-25. The purpose of the Active Filter module is to multiplex dc signals to the A/D Converter and to switch analog filters into the signal conditioner inputs. Figure 3-7 is a block diagram of the Filter/External Reference module. Either the fast or the slow filter may be selected from the front panel. Both filters may be bypassed by

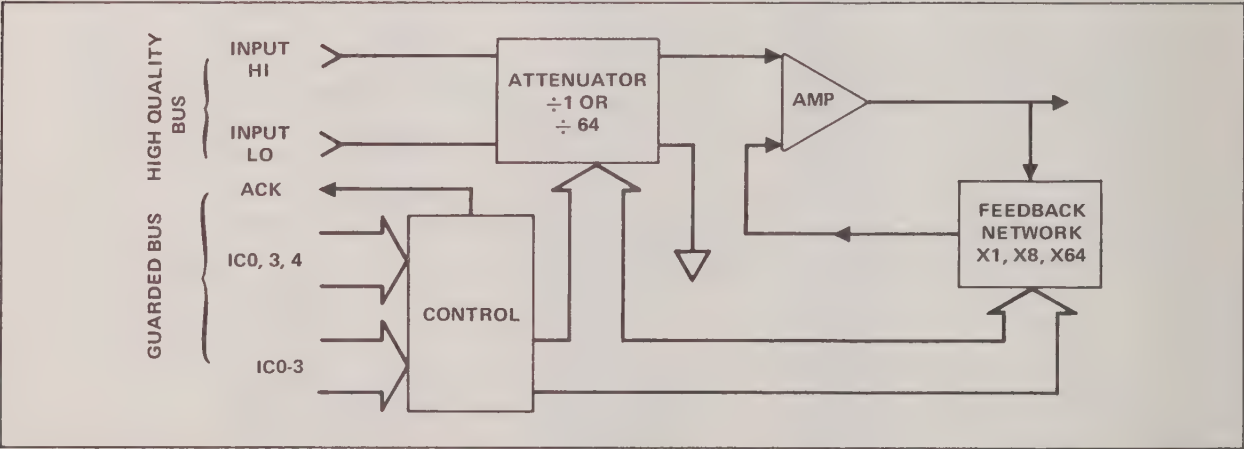


Figure 3-6. DC Signal Conditioner Block Diagram

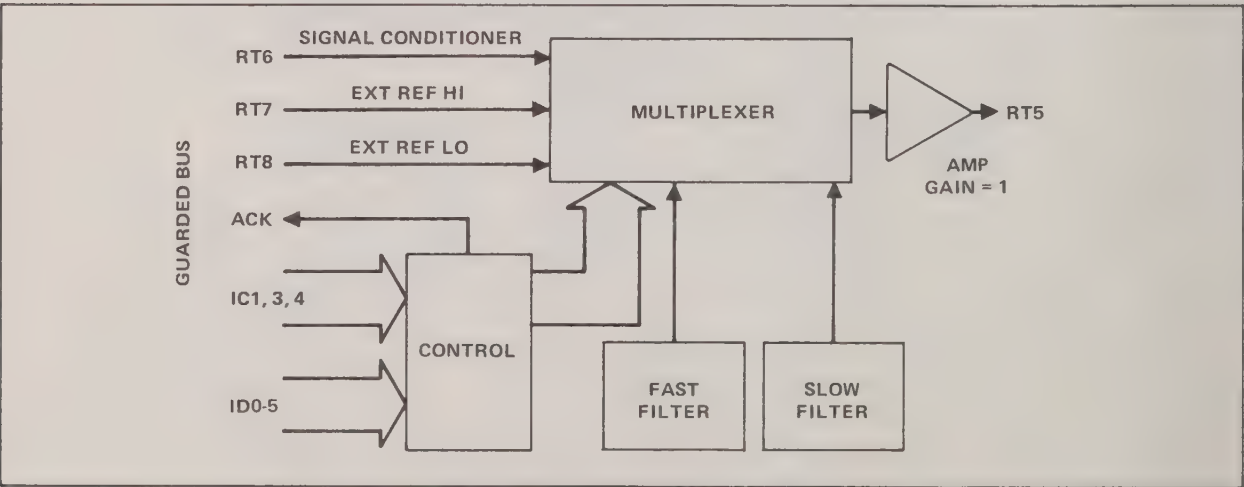


Figure 3-7. Active Filter Block Diagram

command from a remote interface. For external reference measurements, the signal conditioner input, the External Reference HI input and the External Reference LO input are multiplexed to the A/D Converter. Samples are taken of each input and arithmetically manipulated by the Controller to arrive at a reading. Outputs from the optional AC converter modules are applied to the Active Filter module, bypassing the DC Signal Conditioner.

3-26. Fast R^2 A/D Converter

3-27. The Fast R^2 A/D Converter employs Fluke's patented recirculating remainder (R^2) technique for converting a dc input signal into a binary, bit-serial data stream. The R^2 technique has been modified for microprocessor control. Obtaining a sample is a five-step process. Each step consists of a decision period of five decisions and a subtraction period. Set-up of the converter, decisions, and reset are initialized by the Controller addressing the A/D Converter. Figure 3-8 is a block diagram of the R^2 A/D Converter.

3-28. During the first step, the input signal is applied to the Summing Node. The polarity of the input is detected and that bit of information is transmitted to the Controller. On the basis of the returned polarity, the A/D module selects which reference polarity is required—positive for negative inputs, and vice versa. The first of five precision currents is switched into the Summing Node and a polarity bit returned. If the polarity changed, the first current is

switched off. If not, it is left on. Then the next current is switched into the summing node and another polarity bit returned. Another decision is made and so on until all five currents have been switched into the summing node and five decisions have been made. This completes the first decision period. The five precision currents are related by powers of two. The fifth current has a resolution of thirty-two.

3-29. Following the decision period is a subtraction period. Feedback through the Remainder Storage nulls whatever remainder was left after the five currents have been switched into the summing node. The remainder is amplified by sixteen by the Remainder Amp and is stored on a capacitor in Remainder Storage. This completes the first step. The input is now switched out of the Summing Node and the amplified remainder switched in for the next step. There are two remainder channels in Remainder Storage and they are alternated in the four subsequent steps. Since the fifth current has a resolution of thirty-two and the remainder amp has a gain of sixteen, the first bit of a step has the same weight as the last bit of the previous step.

3-30. Of the five steps required to complete a sample, the first uses the input signal for decision and subtraction periods. The four subsequent steps alternate remainder channels to use the amplified remainder of the preceding step for decision and subtraction periods. Polarity bits

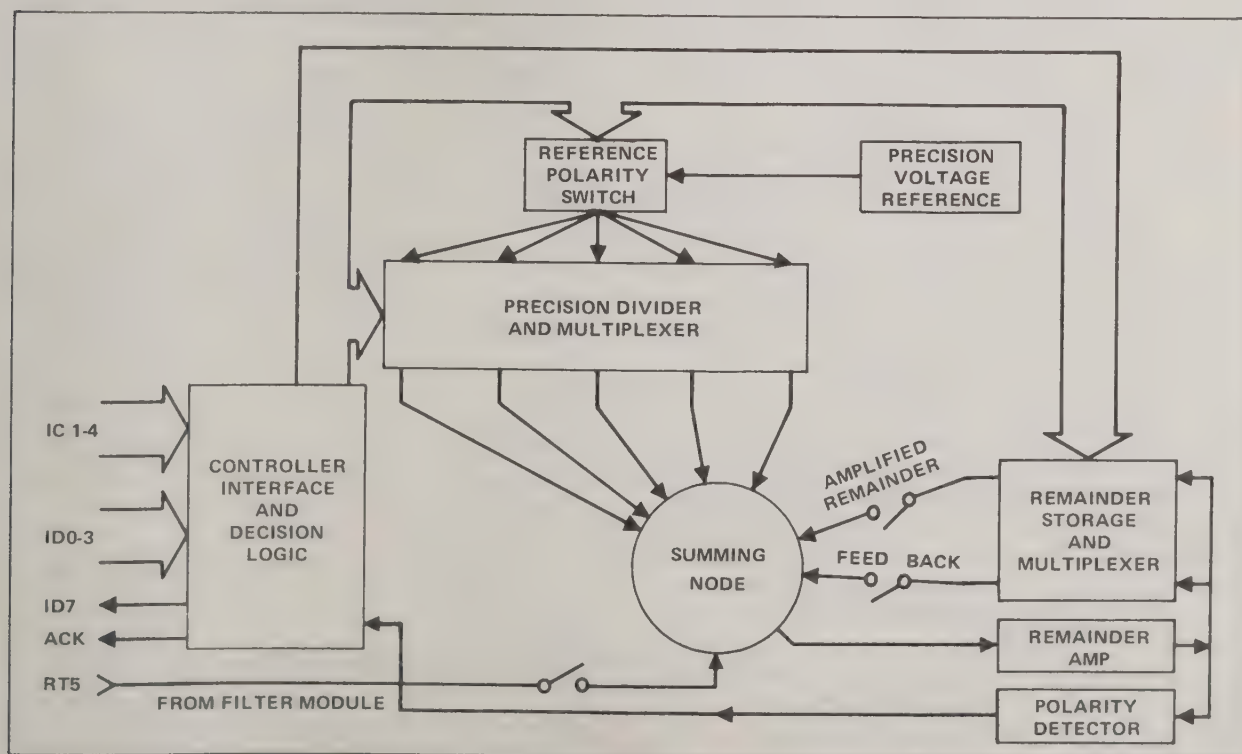


Figure 3-8. R^2 A/D Converter Block Diagram

returned at each decision are accumulated by the Controller and assembled into a 24-bit word describing the polarity and magnitude of the input.

3-31. CIRCUIT ANALYSIS

3-32. Introduction

3-33. The following circuit analyses detail the functioning of the circuitry composing each module in the 8500A/AE mainframe. Optional modules are covered in Section 6. Block Diagram Description should be read first to get an understanding of the overall functioning of the instrument. Simplified schematic diagrams are referred to by figure number. Complete schematic diagrams are located in Section 8 (Section 6 for optional modules). Table 3-1 is a list of mnemonic definitions used in the Controller schematic.

3-34. Controller

3-35. TIMING

3-36. The 8080 microprocessor requires two 12V clock inputs whose phase relationship must fall within certain limits (Figure 3-9). The period of the $\phi 1$ clock (588 nsec) governs the duration of a machine state (3 to 5 states required for a machine cycle, 1 to 5 machine cycles required for an instruction cycle). A 1.7 MHz crystal oscillator is RC coupled through buffers and gates to provide the two-phase clock signal. R1 controls the positioning of the $\phi 1$ clock pulse (with respect to time) during the $\phi 2$ pulse. The $\phi 2$ clock pulse is inverted and translated to 5 volt TTL levels for other timing functions in the control circuitry.

3-37. Shaped line pulses are applied to a phase-locked loop (U26) which runs at 8 times the line frequency (480 Hz for 60 Hz line, 400 Hz for 50 Hz line). U34 divides the output of U26 by 8 for application to a phase comparator contained in U26. Line synchronization is achieved using the output of the phase-locked loop to time the internal interrupt, MARK INT.

3-38. ADDRESS and DATA BUSSES

3-39. Sixteen address lines are used for addressing memory locations and external modules. Refer to the Controller schematic in Section 8. A0-A7 are used for internal scratch pad memory locations with A8, 9, 11, 12, 13 decoded as a RAM chip select. A0-A10 are used for internal ROM locations with A11, 12, 13 decoded as a ROM chip select. A14 is used as ROM/RAM select (high for RAM). A8-A14 are used for external addresses with A15 used as external/internal select (high for external). These address lines are inverted when driving the IC lines on the Interbus. The data bus is eight lines (DB0-7) connected directly to memory and to the external data bus (ID0-7) through tristate I/O buffers.

Table 3-1. Mnemonic Definitions

ACK	— acknowledge
ACK LAT	— acknowledge late
AR	— analog return
DB	— data bus
DBIN	— data bus input signal (from μP)
DLD ACK	— delayed ACK
EN INT	— enable interrupt
HLDA	— hold acknowledge
IB ADX	— interbus address
IBIN	— interbus input signal
IC	— interbus control
ID	— interbus data
IINT	— internal interrupt
INA	— interrupt acknowledge (from controller)
INT	— interrupt
INTA	— Interrupt acknowledge (status word from μP)
INTE	— interrupt enable (from μP)
MEM RD	— memory read
MS ADDR BYTE	— memory select address byte
$\phi 1$	— clock pulse
$\phi 2$	— clock pulse
ϕLL	— phase-locked loop
RAM	— random access memory
ROM	— read only memory
RRDY	— reset ready
RST	— reset
RT	— real time
R/ $\overline{W}$	— read/ $\overline{\text{write}}$
μP	— microprocessor
VA	— analog supply voltage
$V_{CC} \phi 2$	— 5V clock pulse
$V_{DD} \phi 2$	— 12V clock pulse
SRDY	— set ready
SYN IINT	— synchronized internal interrupt
TTL PU	— TTL pull-up
WO	— write out
WR	— write

3-40. RESET

3-41. Shaped line frequency pulses are applied to U36 and U34 to provide a reset on power up or power down (Figure 3-10). U36 is a retriggerable one-shot multivibrator which is cleared on power up by Delayed Vcc. Clearing U36 sets U35 to the Reset condition. After the clear on

U36 is removed (Delayed V_{CC} high), U34 clocks U35 out of the reset condition on the eighth line pulse. At power down, U36 changes state at a time determined by R18 and C22, setting U35 to the reset state.

3-42. STATUS LATCH

3-43. During the first state of every machine cycle, the microprocessor sends a status word out on the data bus. This is at the same time and duration as the SYNC output. SYNC ϕ_2 clocks the status word into a hex "D" latch, U18. Outputs from U18 (Figure 3-11) are used in various portions of the control circuitry.

3-44. WAIT LOGIC

3-45. When the microprocessor addresses an external module (A15 high) or is interrupted, the WAIT logic causes the microprocessor to enter a wait state by pulling the

ready (RDY) line low (Figure 3-12). $\overline{SRDY}$ is normally high and is pulled low to exit the wait state. $\overline{RRDY}$ is normally low and goes high to enter the wait state. A15 TTL is high for an external address, so $\overline{RRDY}$ will go high at SYNC TTL (derived from the microprocessor). For interrupts, the interrupt enable (INTE) signal is inverted for application to U8. INTE enables INT and is removed before INT falls low (due to an RC delay in the INT CONTROL circuit) so that INT and $\overline{INTE}$ are high long enough to clock U1 for a wait signal.

3-46. Three possible combinations will cause the microprocessor to exit a wait state. If an ACK signal is missing, $\overline{ACK}$ INT TTL will pull $\overline{SRDY}$ low. For external addresses, and external interrupts, A15 + INTA and ACK LAT will pull $\overline{SRDY}$ low. For internal interrupts SYN IINT and

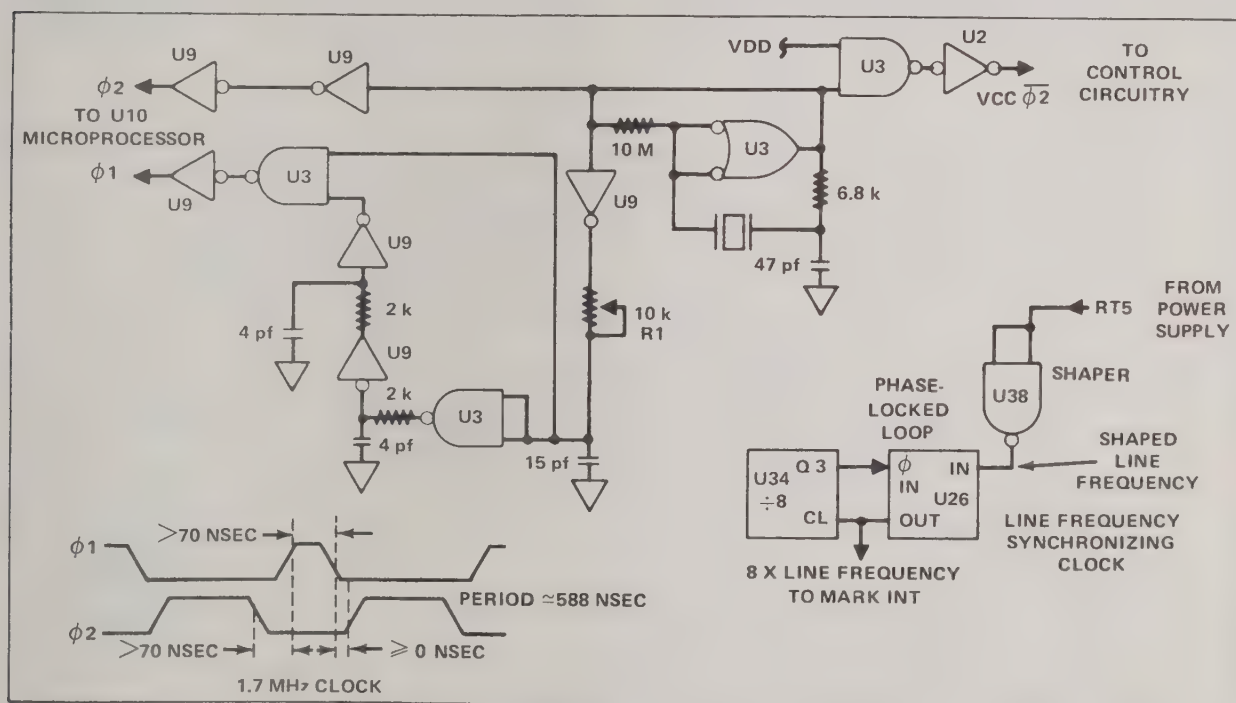


Figure 3-9. Timing Circuits

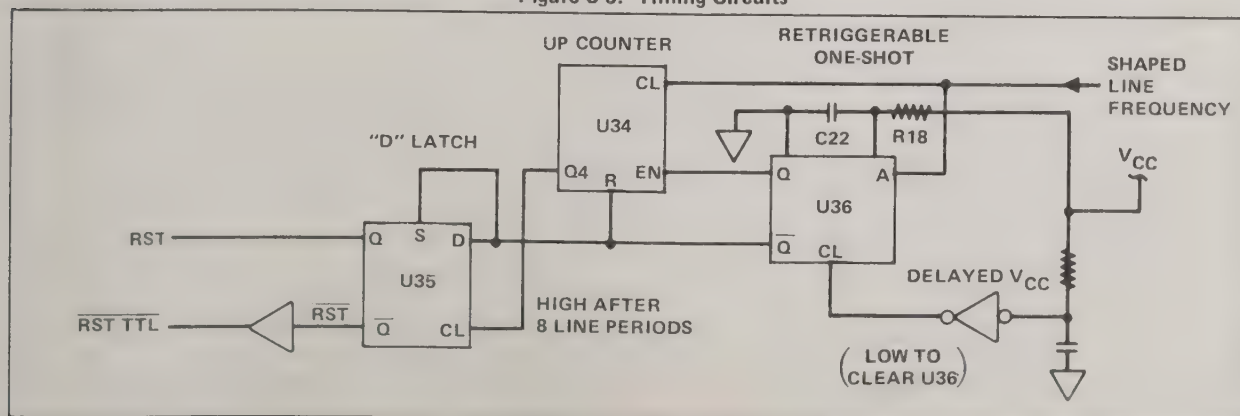


Figure 3-10. Reset Logic

INTA remove the wait state limiting the wait time to a single machine state.

3-47. ACK LOGIC

3-48. When a module is addressed by the Controller, or enabled for interrupt identification by INA from the Controller, it must return an ACK (high) signal. Refer to Figure 3-13. Either INTA (for interrupts) or A15 (for external addresses) together with the delayed ACK signal produce $\overline{\text{DL}}\text{D ACK}$ for U38. $\overline{\text{DL}}\text{D ACK}$ resets the ACK interrupt logic, which is timing the wait for ACK, and produces the ACK LAT signal through U15 and U27. RRDY must be low to get ACK LAT. This synchronizes ACK LAT to the SYNC TTL signal. ACK LAT (or ACK INT TTL if an ACK is missing) causes the microprocessor to exit the wait state.

3-49. INTERRUPTS

3-50. Two internal interrupts and four possible external interrupts are applied to the interrupt (INT) control logic (Figure 3-13). A low on OR gate U17 places a high on NAND gate U38. When INTE is high from the microprocessor (during the last state of an instruction cycle), U38 outputs a low through an RC delay network to U32. U32 inverts the signal and places a high on the INT line to interrupt the microprocessor. The microprocessor drops INTE low, then puts out an interrupt acknowledge (INTA) as a status word which is latched up in the Status Latch, U18. Then the microprocessor enters a wait state until the interrupt and its priority are identified through INT VECTOR, U28 (Controller schematic, Section 8).

3-51. Internal interrupts are ACK INT and MARK INT (Figure 3-14). ACK INT logic consists of a retriggerable

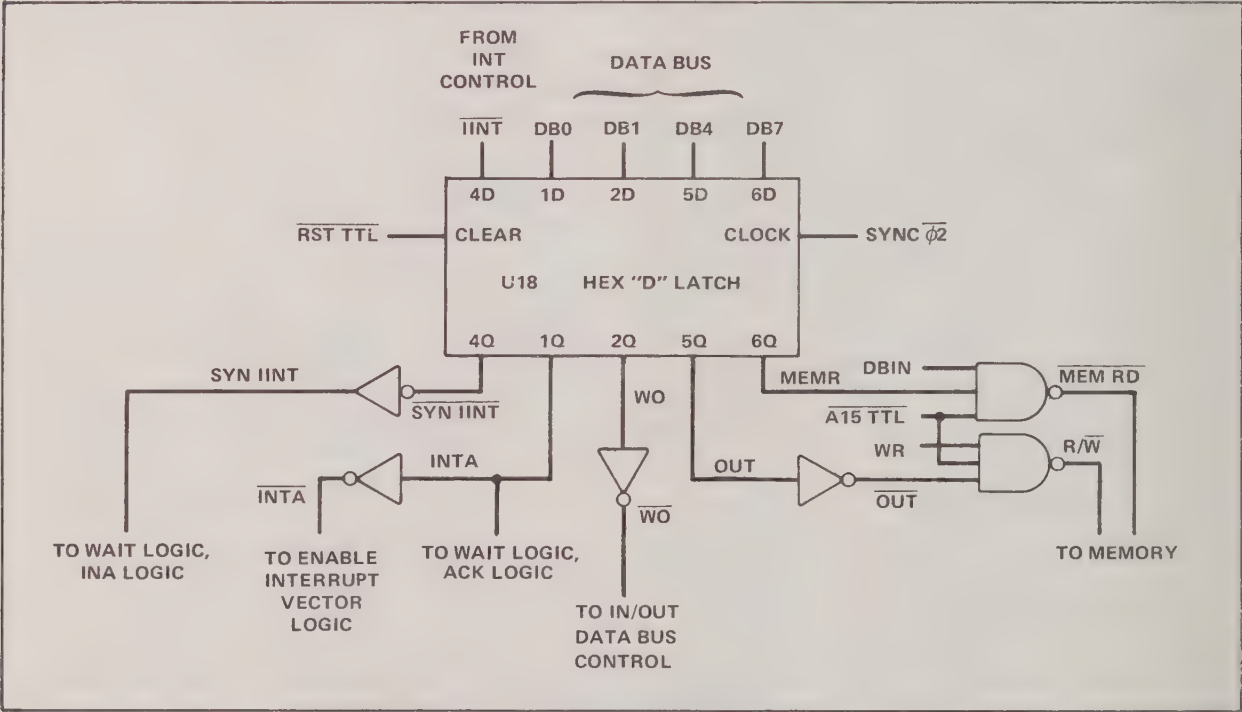


Figure 3-11. Status Latch

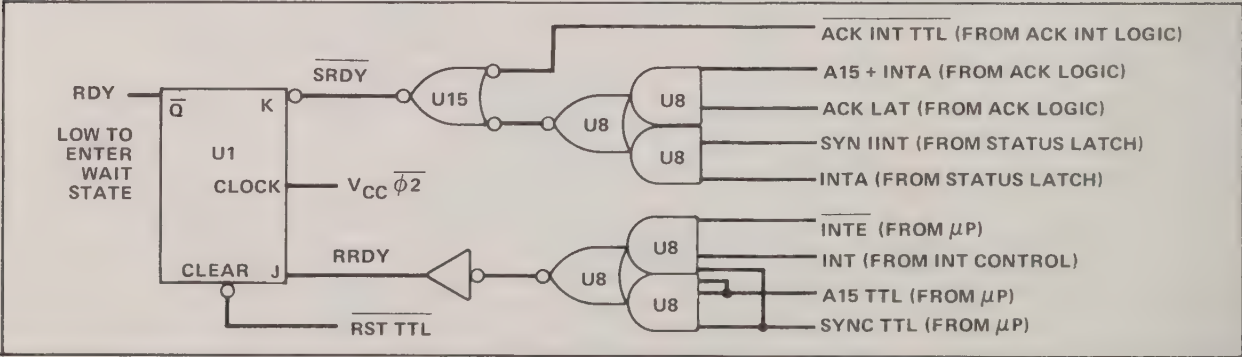


Figure 3-12. Wait Logic

monostable multivibrator, U36, and a "D" type flip-flop, U14. U36 is triggered by A15 TTL and SYNC $\phi 2$. If $\overline{\text{DLD ACK}}$ does not occur within the time constant of U36, U36 will clock U14 to generate ACK INT. ACK INT TTL is also generated by U14 to end the wait state resulting from the external address.

3-52. The MARK INT logic is armed by an internal address keyed to RAM. A15 TTL is high indicating an internal address. DB4 is high as part of the status word indicating an address to an output device. A15 TTL and DB4 (both high) with SYNC $\phi 2$ clock U1 through U31-12. A14 is low for a RAM address so U1-7 is clocked high. Although the address which arms the mark is keyed to RAM, no data transfer takes place between the microprocessor and RAM. The write signal (R/W) is disabled by OUT from the STATUS LATCH. MEM RD (memory read) is disabled by DBIN (from the microprocessor) and MEMR

(from the STATUS LATCH) both being low. After ARM MARK (U1-7) is clocked high, the next pulse from the phase-locked loop timing circuit clocks U14 to generate the MARK INT signal.

3-53. Interrupts are prioritized through INT VECTOR (refer to Controller schematic, Section 8). Before entering a wait state after an interrupt, the microprocessor puts out a DBIN signal, signifying that it is ready to receive data. DBIN and INTA produce EN INT through U37 to enable the Interrupt Vector (U28). Internal interrupts are applied directly to U28 and have priorities of one (highest) for ACK INT and six (lowest) for MARK INT. For an internal interrupt, $\overline{\text{IINT}}$ is generated by one section of U38 (Figure 3-13) and, when latched into the Status Latch (U18), is used to end the wait state. For an external interrupt, SYN IINT is low and with $\overline{\text{EN INT}}$ low, INA is generated on the interbus. The interrupting module must respond with an

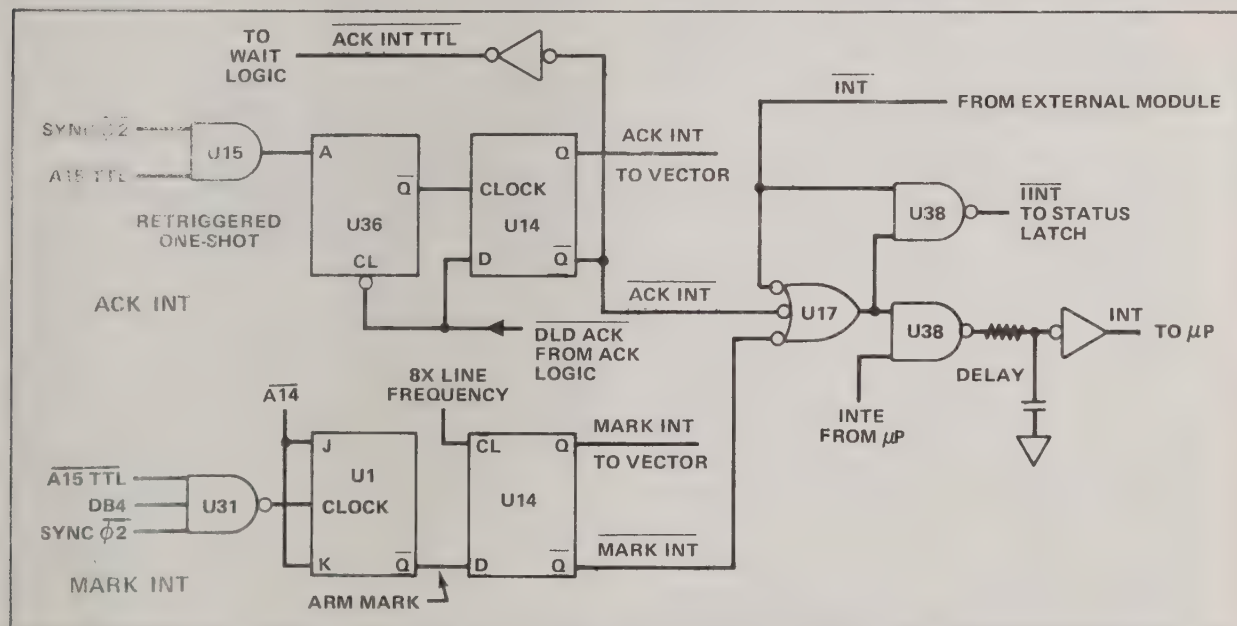


Figure 3-13. Internal Interrupts and INT Control

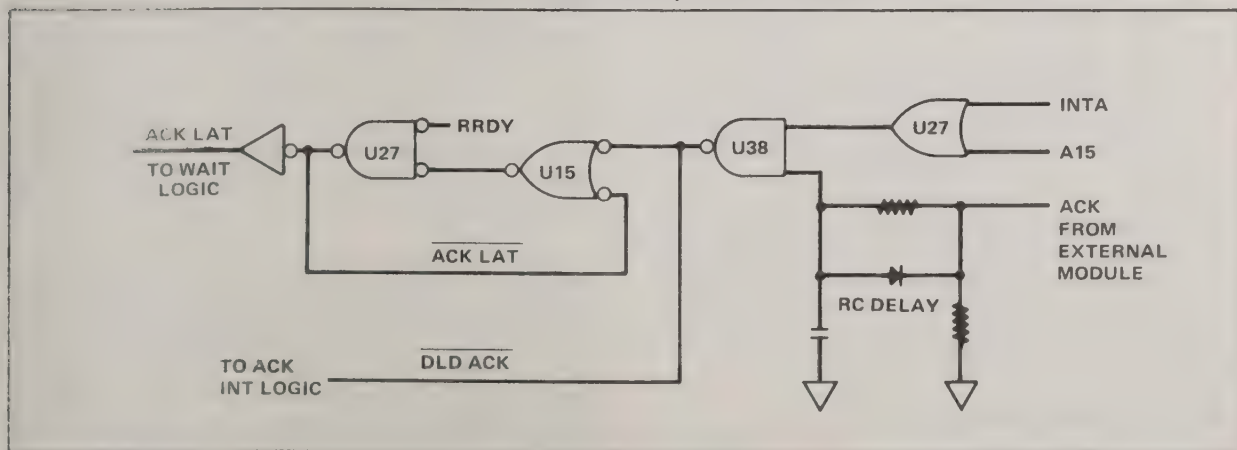


Figure 3-14. ACK Logic

ACK and a data bit on ID1-4. The returned ACK ends the wait state and the data bit is applied to INT VECTOR, U28. The complement of the output from U28 is placed on the data bus to instruct the microprocessor where to go for the next instruction.

3-54. Front Panel

3-55. Annunciator segment data is clocked into register one by the direct address, IC0, 1, 5 high. Refer to Figure 3-15. Data output from the switch matrix is also a direct address—IC0, 1, 6 high. For either direct address, the condition of ID7 (high for disable) is latched into U23 to enable an indirect address. Digit segment address—IC1, 5 high, and digit-annunciator select address—IC0, 5 are both indirect addresses. Data is clocked into the registers upon termination of the address. An update sequence is as follows:

1. Register one is addressed with all data lines low to blank the annunciator display and enable indirect addressing.
2. Register two is addressed indirectly with data lines low to blank the digit display.
3. Register three is addressed indirectly with all data lines high to turn off all LEDs, disable the switch matrix, and disable indirect addressing.
4. Register one is addressed with ID7 low to enable indirect addressing and with annunciator segment data on ID0-6. The data is latched and applied to the annunciator LEDs.
5. Register two is addressed with digit segment data on ID0-7 (U23 is not clocked by this address so ID7 may be high without disabling indirect addressing). The data is latched and applied to the digit LEDs.
6. Register three is addressed with ID7 high (disable indirect addressing) and one of the data lines, ID0-6, low to enable one digit LED and one annunciator LED. One bank of the switch matrix is also enabled.
7. The output buffer is addressed enabling the data from the previously enabled switch bank to be placed on the data bus. One or more lines low indicates a change is desired. This address also keeps the kill circuit charged.

3-56. The seven steps just outlined are required for one digit-annunciator-switch bank update. The process is repeated seven times for a complete update. The kill circuit is used to blank the display if the Controller discontinues addressing the front panel. Otherwise, segments would be left on continuously and would soon burn out.

3-57. DC Signal Conditioner

3-58. Relays K1 and K2 control the input to the DC Signal Conditioner and the attenuation of the input (Figure

3-16). If both relays are energized, the input is from the Volt/ Ω input terminals with $\div 64$ attenuation. If just K1 is energized, the input is from the Volt/ Ω input terminals with no attenuation. If just K2 is energized, the input is from RT1 (optional signal conditioners). Q10, Q11, CR3, and CR4 provide overvoltage protection.

3-59. Q18 and Q19 are configured as a differential amplifier driving U3. Q14, Q15, and Q16 are FET switches controlling the gain of Q18, Q19, and U3. U4, Q33, and Q37 provide bias for Q18 and Q19. U4 provides a bootstrap effect while Q33 and Q37 are a current sink and source. U5 and U6 provide bootstrapping for U3 and U4. Bootstrapping is used to provide an output voltage swing of $\pm 20V$ without requiring high-voltage amplifiers.

3-60. The DC Signal Conditioner is addressed by IC0, 3, 4 high. Data on ID0-3 is latched up and decoded to determine which switches and relays will be energized. Figure 3-16 includes an example of the relay driver used to minimize thermal changes in the relays between the on and off states. RC coupling between the decoder and the relay driver provide voltage swings up to 4V or down to 0V to ensure positive relay action. Steady state voltages of 1.45V (off) and 2.75V (on) minimize current differences between the on and off states while maintaining the relay state under all conditions.

3-61. Filter/External Reference

3-62. All inputs to the A/D Converter are routed through the Filter/External Reference module. Refer to Figure 3-17. External reference measurements are made by multiplexing the three Filter module inputs to the A/D Converter. Q18, Q19, and Q20 switch the signal conditioner input, the external reference LO input, and the external reference HI input respectively. Data controlling the switches is latched into U1 upon termination of the address (IC1, 3, 4 high).

3-63. U3 and U4 are configured as three-pole, active Bessel filters having different settling times and cutoff points. Either filter may be selected from the front panel for application to the signal conditioner input. Bypass is automatically selected for external reference inputs or may be remotely selected for signal conditioner inputs. The combination of Q32 Q25, Q23 Q24, or Q21 Q22 is turned on to select a filter mode.

3-64. Q27 is a dual, super-beta transistor in a differential configuration driving U5. Q26 and Q30 are a current source and sink biasing Q27. Q26 draws enough current through R19 to bootstrap the input amplifier, Q27, 5V above the output. Gain of the amplifier is set at one by the combination of R21 and the input resistors. The external reference inputs have additional series resistors located at the rear panel terminals.

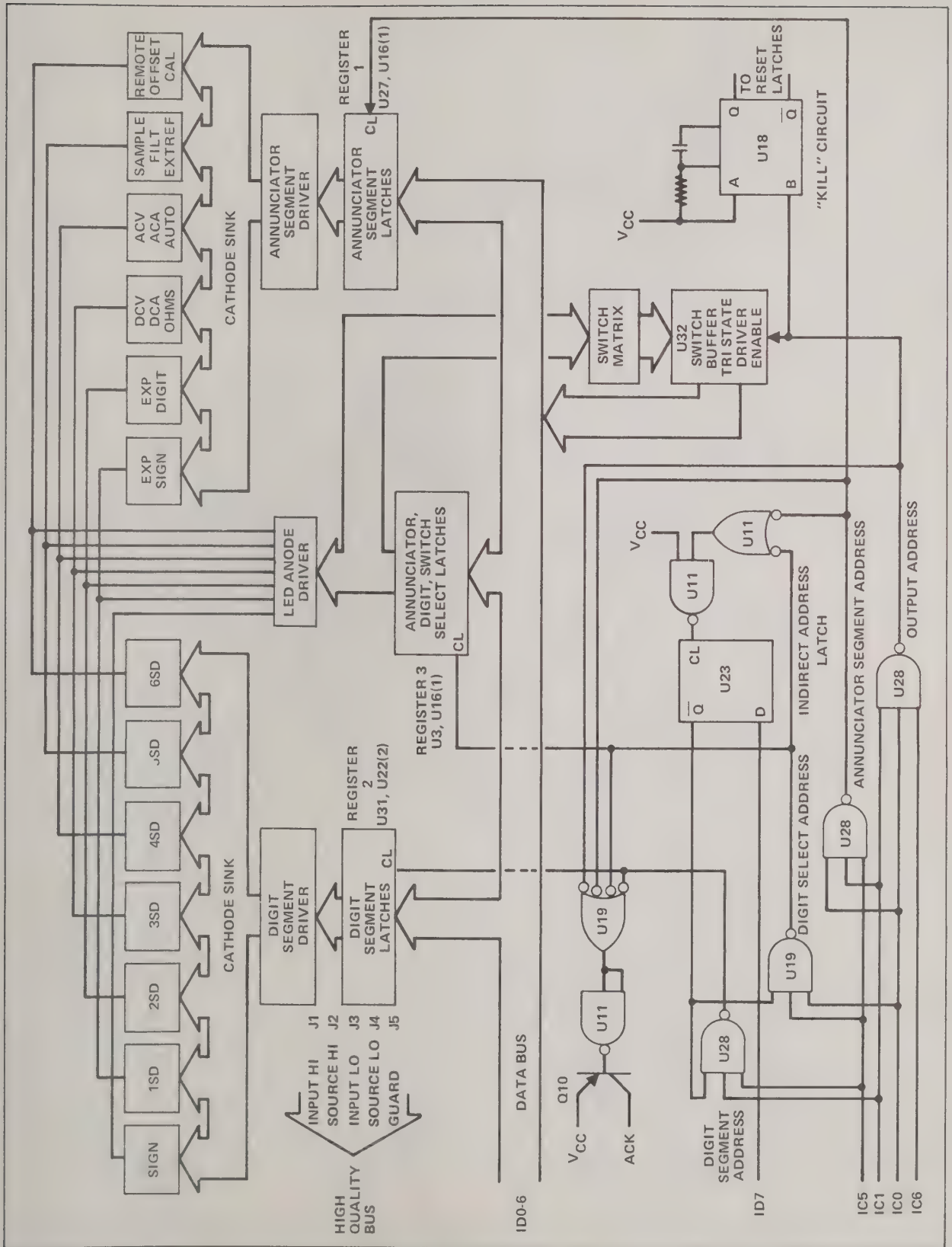


Figure 3-15. Front Panel

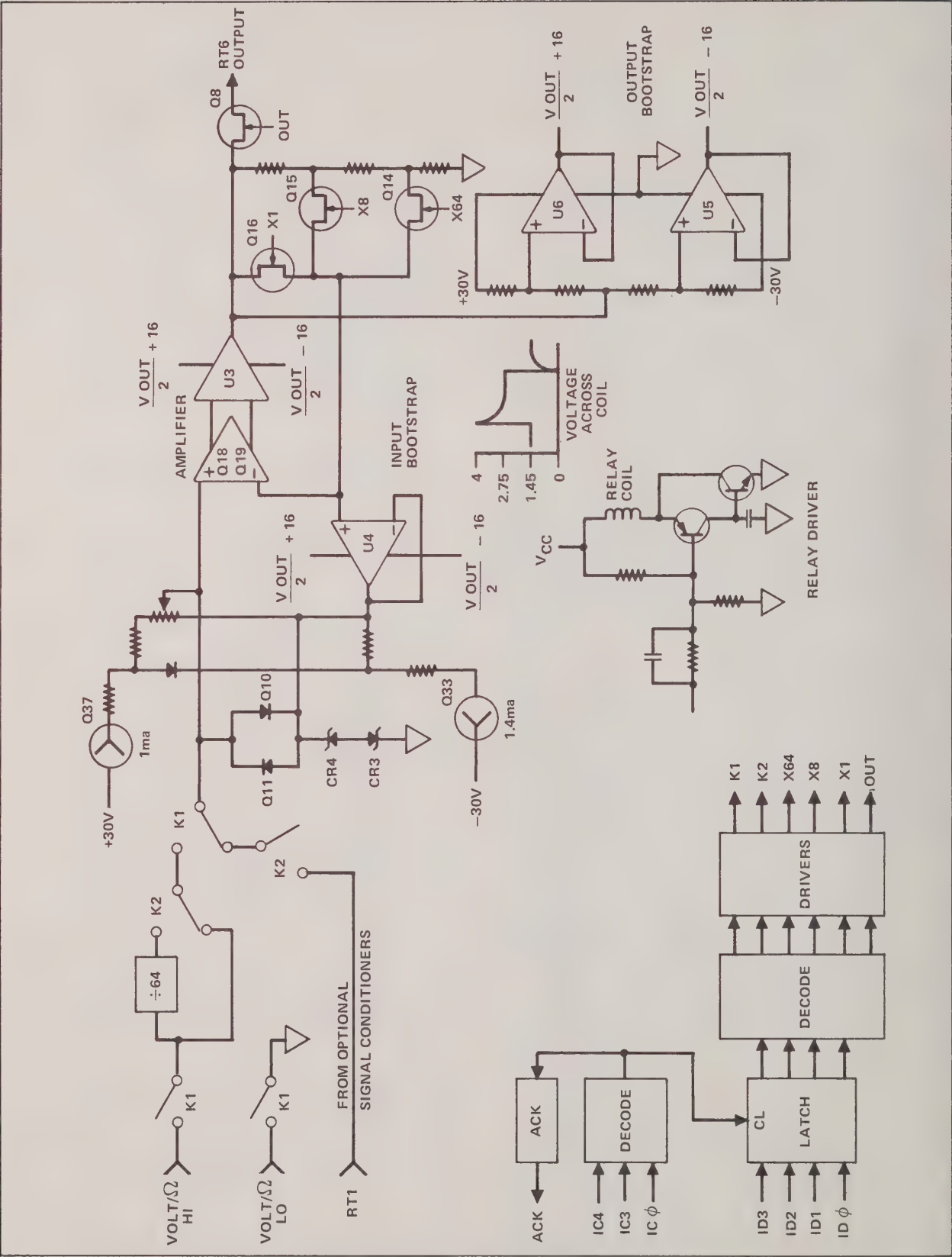


Figure 3-16. DC Signal Conditioner

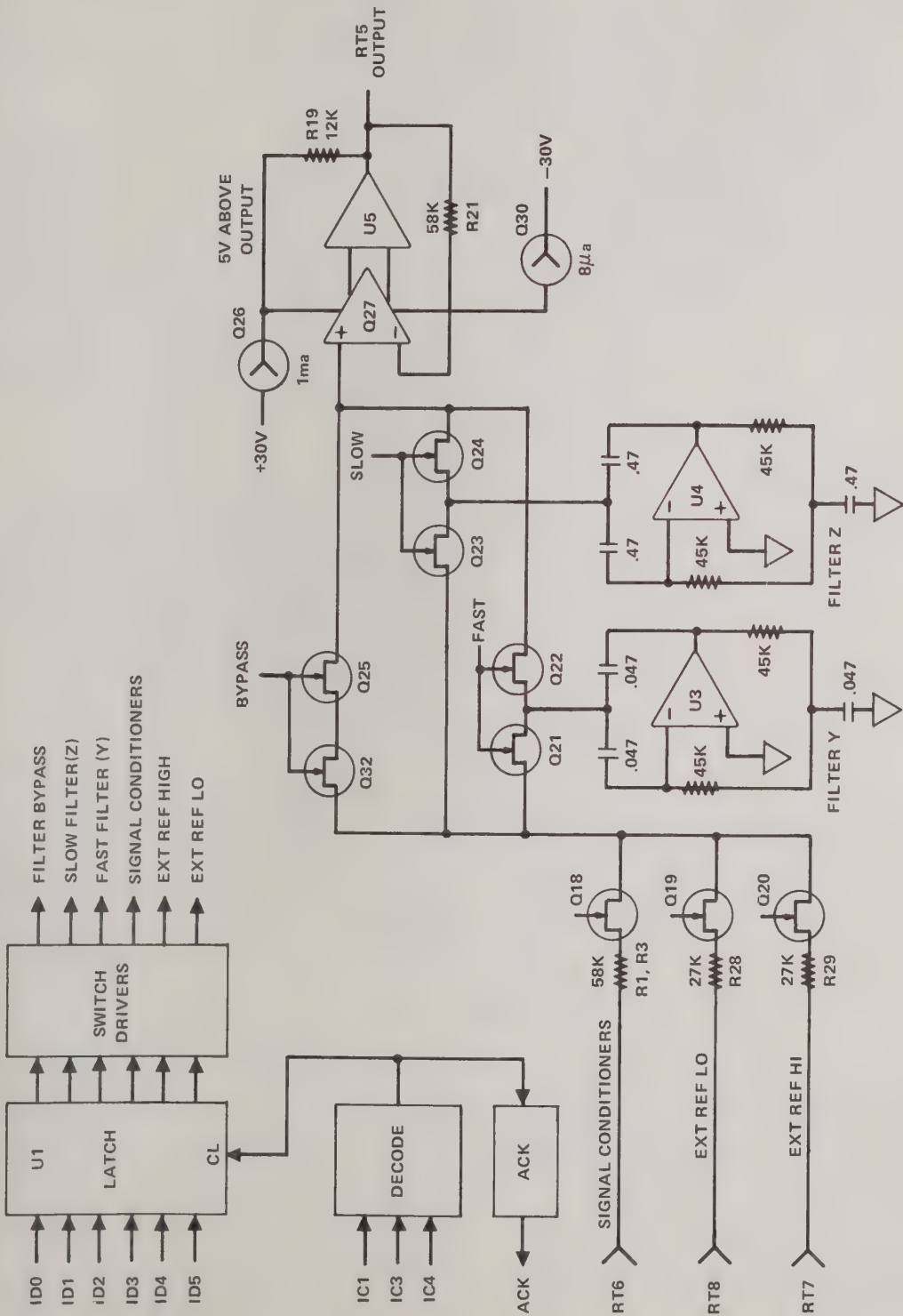


Figure 3-17. Filter/External Reference

3-65. Fast R^2 A/D Converter

3-66. The Fast R^2 A/D Converter may be separated for analysis into two component groups: Analog and Digital. Analog circuitry is responsible for producing a voltage reference, for summations, and for remainder amplification and storage. Digital circuitry interfaces the analog circuitry to the Controller and is responsible for reference selection, decisions in the summation process, remainder channel control, and autozeroing. Since functions within the A/D Converter are either directly controlled by the Controller module via the data bus or are clocked through their operations by the Controller addressing the A/D module, the A/D conversion program could be considered a functional part of the A/D Converter.

3-67. ANALOG

3-68. Figure 3-18 is a simplified schematic of the analog portion of the A/D Converter. For clarity, switches are shown as a circle enclosing a letter designator. U1 is a reference and reference amplifier controlling U2, a current source. The $-7V$ reference is set by R9 and R14. U3 serves as a highly regulated collector and zener supply for U1. Operation of the D/A Converter requires both a positive and negative reference (for negative and positive inputs, respectively). Q9 and U4 are a precision unity gain amplifier whose input is controlled by switches A1 and A2. With A1 open and A2 closed, Q9 and U4 are configured as an inverting amplifier producing a positive reference. With A1 closed and A2 open, Q9 and U4 are a noninverting amplifier.

3-69. An input signal is applied to the summing node of the remainder amplifier (Q27, U7) through switch I. Q27 and U7 are an inverting amplifier with two gain configurations. During the decision period, switch G is closed, applying the output of U7 to polarity detector Q28 and forming a feedback path through CR5 and CR6. Q28 sends a polarity bit to the digital portion of the circuitry. On the basis of this first polarity bit, a reference polarity is selected.

3-70. Switches B, C, D, E, and F are closed, one at a time, to switch a precise amount of current into the summing node. When a switch is closed, the opposite switch is opened and vice versa. For example, when D is closed, D is opened. After a switch is closed, a polarity bit is returned. If the polarity changed with respect to the original polarity selected for a step, the switch is opened; otherwise it is left closed. The next switch is closed, a polarity bit returned and a decision made, and so on until all five switches have been closed (and possibly opened again). This constitutes a decision period.

3-71. Following the decision period is the subtraction period. Switch G is opened and switches X and SX are

closed to form a feedback path for the remainder amplifier through the X channel. A 400K resistor, R35, sets the gain of Q27 and U7 at sixteen. The feedback current completes the summation process and the amplified remainder is stored on C10 in the X channel.

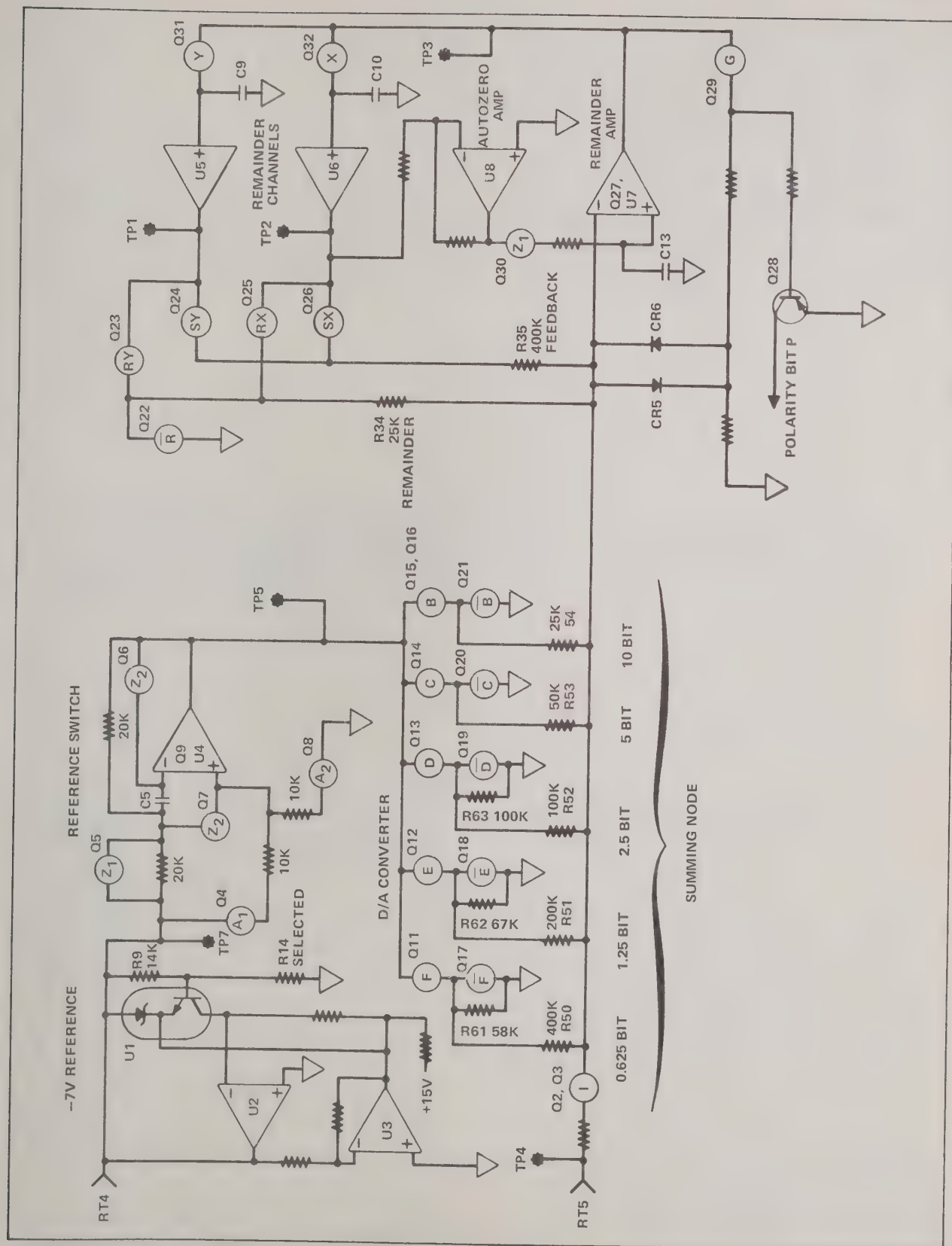
3-72. For the next decision period switches SX and X are opened and switches RX and G are closed. Since Q27 and U7 form an inverting amplifier, the opposite polarity reference (from the original selection) is automatically selected. The amplified remainder is applied to the summing node through U6 and R34. Five decisions are made, followed by a subtraction period using channel Y for feedback and remainder storage. The first decision-subtraction period applies the input signal to the summing node. The four following steps apply an amplified remainder, alternating between channel X and channel Y.

3-73. When a sample is complete, the circuits are autozeroed. U8 zeros the remainder amplifier through channel X. Any offset is stored on C13 at the noninverting input of Q27. The switching reference, Q9 and U4, is zeroed by first closing A1 and opening A2 to decrease settling time. Then A1 and A2 are both opened and the Z1 and Z2 switches are closed, storing any offset error on C5.

3-74. DIGITAL

3-75. For the following discussion, refer to the Digital Fast R^2 A/D schematic in Section 8. Direct address IC2, 3, 4 latches data into U34 and U35 controlling input switch I, remainder channel switches, autozero, and reset (digital). U31, a ring counter, is clocked to the C1 state enabling the indirect address decoder (U33) and the polarity detector (switch G). A polarity bit is returned and applied to U6.

3-76. Indirect address IC1, 2 latches the polarity bit in U6, enables the tristate transmitter, U5, and clocks U31 to the C2 state. The transition of U31 from C1 to C2 clocks the polarity into U11 (the uppermost section) whose output determines whether switch A1 or A2 will be closed (reference polarity). At the same time, U1 (uppermost section) is clocked to set the other section of U11, closing the first reference switch, B, of the D/A Converter. The next indirect address clocks a new polarity bit (a result of closing the first reference switch B) into U6. If the polarity changed, the output of U6 will cause a reset of the previous switch latch, opening the previous switch. At termination of the address the next switch is closed. One direct address and six indirect addresses are required to complete a step. The last indirect address resets the control logic to the C0 state.

Figure 3-18. Fast R^2 A/D Converter (Analog)

3-77. Switch selections are made through switch drivers which rely on V_{cc} and V_{ss} being at $-15V$ and $-20V$ with respect to analog common. This allows simple transition from TTL levels to FET off voltages. D/A Converter switches are selected on transition of U31 from one state to the next. The transition clocks the first of two "D" flip-flops which sets the second. The output of the second latch resets the first and selects the switch. If the polarity does not change after closing a switch, the output of U6 plus the output of U11 (reference select) will place two highs on the input of one section of AND gate U25. Through OR gate, U16, a one will be applied to the D input of that switch latch. The next transition of U31 will clock

the latch, keeping the switch closed. If the polarity had changed, a zero would be applied to the D input, opening the switch.

3-78. After the last step, at completion of a sample, the Controller addresses the A/D Converter for autozero. U31 is clocked to the C7 state causing a digital reset. When U6, storage capacitor disable, is reset, autozero is enabled. RC coupled gates delay the zero switch controls so that switch A1 may be closed and A2 opened in the reference switching circuit. This provides a faster settling time for the reference switching amplifier. Both A1 and A2 are opened during the autozero time.

Section 4

Maintenance

WARNING!

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual contains performance tests, calibration procedures, and maintenance information including general maintenance and troubleshooting. Calibration intervals may be determined by the user according to the accuracy desired (specifications are listed in Section 2). One year is the recommended maximum calibration interval. Test equipment recommended for performance tests, calibration adjustments, and troubleshooting is listed in Table 4-1. If the recommended equipment is not available, equipment of equivalent specifications may be used.

4-3. SERVICE INFORMATION

4-4. Each instrument manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is located at the front of the manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of domestic service centers is located in Section 7 of the manual. Shipping information is given in Sec-

tion 2. If requested, the customer will be provided an estimate before any work begins on instruments that are beyond the Warranty period.

4-6. GENERAL MAINTENANCE

4-7. Line Voltage Selection

4-8. Input line voltage is switch selectable between 115V ac and 230V ac (check Section 2 for line voltage and frequency limitations). Removal of the top cover of the instrument allows access to the switch, located in the left front corner on the power supply board. Turn off the power and disconnect the line cord before removing the cover.

4-9. Fuse Replacement

4-10. Two fuses are located on the rear panel. The line fuse (MDL ½A) is found near the heat sink; the rear input current/ohms protection fuse (AGC 1½A) is immediately above the rear input connector. On the front panel, the front input current/ohms protection fuse (AGC 1½A) is located in the lower right corner.

Table 4-1. Test Equipment

NOMENCLATURE	MINIMUM USE SPECIFICATIONS	RECOMMENDED EQUIPMENT
DC Source	High Short-Term Stability Range: 0 – 1100V	Fluke Model 335A
Null Detector	10 μ V Full-Scale Resolution	Fluke Model 335A
Reference Divider	$\pm$.001% Division Accuracy	Fluke Model 750A
Kelvin-Varley Divider	Linearity: $\pm$.1 PPM of Input	Fluke Model 720A
Standard Cell Enclosure	Guildline 91	Guildline 9152 (R)
Oscilloscope	General Purpose with 10M Ω Probe	Tektronix 465
Digital Multimeter	Voltage Accuracy: .01% Input Impedance: 1000 M Ω	Fluke Model 8800A
Low EMF, Shielded Connector Cables	Gold-plated Spade Lug Connectors	
Extender Card		Fluke Model MIS-7011k
Bus Monitor		Fluke Model MIS-7013k
AS REQUIRED BY INSTALLED OPTIONS		
AC Calibration System	Voltage Range: 0 – 1000V ac Frequency Range: 10 Hz – 300 kHz Accuracy: 10 Hz – 30 Hz: .1 % 30 Hz – 20 kHz: .02% 20 kHz – 100 kHz: .05% 100 kHz – 300 kHz: .33%	Fluke Model 5200A with Fluke Model 5215A or with Fluke Model 5205A
Current Calibrator with 200 k Ω Resistor	Accuracy: $\pm$.02% $\pm$.01 %	Fluke Model 382A
Standard Resistors	10 Ω at 30 ppm; 100 Ω , 1.9k Ω , 10k Ω , 100 k Ω , 250k Ω , 1 M Ω , 4 M Ω at 10 ppm; 10 M Ω at 50 ppm; 100 M Ω at 100 ppm	ESI SR-1010 ESI SR-1050
Terminating Load	1 M Ω $\pm$ 10%/0.22 μ f Nonpolarized Parallel Load	

4-11. Module Installation and Removal

4-12. Use the following procedure for module installation or removal.

1. Turn off the power and disconnect the line cord.
2. Remove the instrument's top cover.
3. The 8500A/AE allows some choice in the placement of modules. For example, the ohms converter (Option 02) may be placed in slot A, B, C, or D. But the A/D converter will only function in slot H. A complete listing of preferred and permissible slots is offered in Figure 8-2. Slots A – N run from front to rear. Figure 8-1 provides accurate information on slot location (e.g., J11C, J12C, and J13C from slot C). When installing any module, slide it vertically between the module guides and press firmly into place.
4. Open the hinged module top and ensure that the spring guard connection is resting on the guard shield, connecting one half of the guard shield to the other.
5. For removal, grasp the module at both ends and pull up. An end-to-end rocking motion may be used to free the module from the connector.

4-13. Front Panel PCB Removal and LED Replacement

4-14. To remove the Front Panel PCB from the instrument for troubleshooting, repair, or LED replacement, use the following procedure:

1. Ensure that the power is removed from the 8500A/AE.
2. Remove any shorting links from the input terminals.
3. Snap the bezel loose from the frame and remove it from the instrument.
4. Remove any defective LEDs from their sockets and replace.
5. If only LED replacement is required, reassemble in the reverse order. If removal of the Front Panel PCB is required, remove the top cover, remove the pcb retainer from the instrument, then unplug the front panel pcb from the motherboard and remove it from the instrument through the front framework.
6. Reassemble the Front Panel in the reverse order.

4-15. Power Supply Removal

4-16. Remove the Power Supply from the 8500A/AE using the following procedure:

1. Ensure that the power is removed from the 8500A/AE. Remove the top cover.
2. Remove the four screws positioned around the heat sink that secure the power supply to the rear frame.
3. Pull the Power Supply straight back, using a gentle rocking motion to disconnect it from the card edge connector on the interconnect pcb.
4. Reassemble in the reverse order.

4-17. Power Supply Interconnect PCB Removal

4-18. Remove the Power Supply Interconnect pcb from the 8500A/AE using the following procedure:

1. Remove the Front Panel pcb and power supply as described above, if not already done.
2. Remove the three screws securing the interconnect pcb to the framework.
3. Disconnect the pcb's card edge connector from the motherboard connector. Lift the pcb out through the front framework, taking care not to damage the power switch.
4. Reassemble in the reverse order.

4-19. Motherboard PCB Removal

4-20. Remove the Motherboard PCB from the 8500A/AE using the following procedure:

1. Remove the modules, the front panel pcb, and power supply interconnect pcb from the instrument if not already done.
2. Remove the eight screws that secure the motherboard to the bottom framework and lift the motherboard out through the front framework of the instrument.
3. Reassemble in the reverse order.

4-21. Cleaning Instructions

4-22. Periodically (at least every 90 days) clean the 8500A/AE using the following procedure:

1. Ensure that the power is removed from the 8500A/AE.
2. Remove the top and bottom covers from the instrument.
3. Disconnect the modules from the motherboard and remove them from the instrument.
4. Clean the interior of the 8500A/AE using low pressure clean dry air or a vacuum cleaner.
5. Clean the front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened with a mild solution of detergent and water.
6. The rear input connector mounting plate is made of a special high resistance, low-leakage material to minimize leakage error in high resistance measurement. Periodically, and whenever leakage is suspected, clean the plate with a mild detergent; rinse well with hot water.
7. Care should also be exercised when cleaning the front/rear input switch. It is best to use only hot water here.

CAUTION

Avoid use of any degreasing agents when cleaning in or near the front/rear input switch.

8. Replace the modules and covers if access to the instrument interior is no longer required.

4-23. PERFORMANCE TEST

4-24. Introduction

4-25. The following paragraphs contain a Performance Verification Test which compares the operation of the instrument to the specifications in Section 1 of this manual. The test may be used to verify calibration of the equipment

between scheduled calibration periods or as an aid in troubleshooting.

4-26. The test equipment required for the Performance Test is listed in Table 4-1. If the recommended equipment is not available, replacements with equivalent specification may be substituted.

4-27. If the instrument does not meet the specifications listed in the Performance Test, either the calibration procedure or corrective maintenance should be performed, as determined by the symptoms. The test should be performed when the ambient temperature is between 18° and 28° Celsius and the relative humidity less than 75% to attain maximum accuracy.

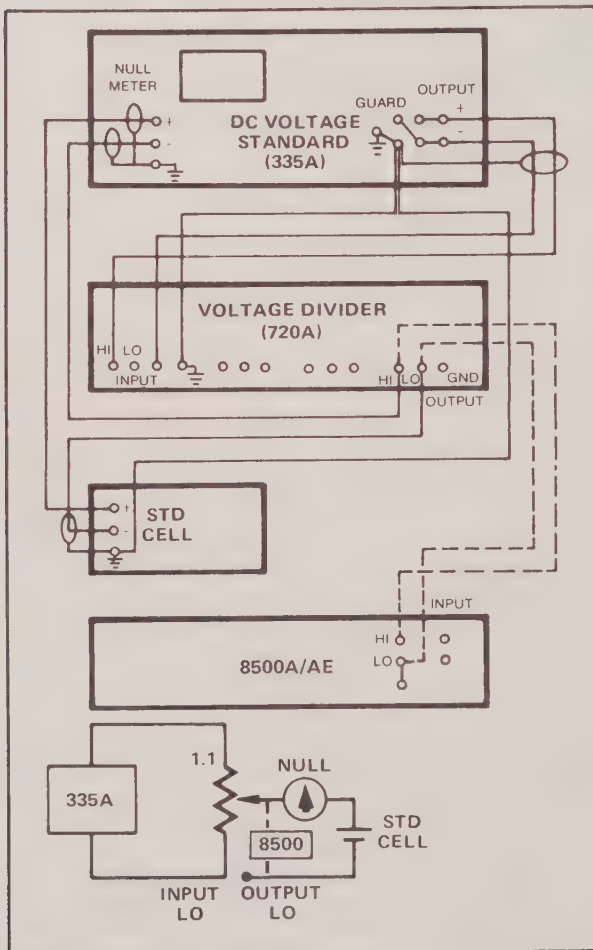


Figure 4-1. Connections For Low Range DC Voltage Tests

4-28. DC Performance Test

4-29. LOW RANGE DC VOLTAGE TESTS

4-30. Perform the Low Range Tests as follows:

1. Connect the equipment shown with solid lines in Figure 4-1. Do not connect the 8500A/AE at this time.

2. Verify that the test equipment is operating properly and their respective warmup periods, as stated in the applicable manuals, have expired.
3. Verify that the 8500A/AE warmup period of one hour has elapsed. Ensure that the VDC and AUTO indicators are illuminated, the SAMPLE indicator flashes approximately eight times per second (32 samples per reading), and all other indicators are extinguished.
4. Set the Voltage Divider controls for one-tenth the standard cell certified value. Adjust the DC Voltage Standard output for a null on the null meter.
5. Disconnect the leads at the Voltage Divider output terminals and connect the 8500A/AE as shown with the broken lines in Figure 4-1.
6. Perform the test listed in Table 4-2, setting the Voltage Divider to the listed outputs. Do not change the output setting of the DC Voltage Standard. After voltage has been applied to the 8500A/AE, but prior to the first reading, toggle the instrument into manual ranging.
7. Reverse the leads at the 335A output terminals (lead previously connected to the HI terminal now connected to the LO terminal and vice versa) and repeat the test listed in Table 4-2, ensuring that the listed outputs are now negative.

Table 4-2. Low Range DC Voltage Tests

RANGE	DIVIDER SETTING	8500A/AE READING	
		LOW	HIGH
100 mV	.0010000	+ 9.995 (1-3)	+ 10.005 (-3)
100 mV	.0100000	+99.992 (-3)	+100.008 (-3)
1 V	.0100000	+ 0.9999	+ 0.10001
1 V	.1000000	+ 0.99997	+ 1.00003
10 V	.1000000	+ 0.9999	+ 1.0001
10 V	1.0000000	+ 9.9998	+ 10.0002

4-31. HIGH RANGE DC VOLTAGE TESTS

4-32. Perform the High Range Test as follows:

1. Connect the equipment as shown in Figure 4-2.
2. Verify that the test equipment is operating properly and any warmup period required has expired.
3. Verify that the 8500A/AE warmup period of one hour is complete. Ensure that the VDC $\overline{\text{r}}$ function is selected with the VDC indicator illuminated and that the instrument is in manual ranging in the 100 volt range. The SAMPLE indicator should be flashing approximately eight times per second (32 samples per reading) and all other indicators should be extinguished.

4. Set the Reference Divider Standard Cell voltage controls to the standard cell certified value and both the input and output controls to 10 volts.
5. Set the DC Voltage Standard to approximately 10 volts, then adjust its output for a null reading on the null meter.
6. The 8500A/AE reading displayed is between + 9.999 and + 10.001.
7. Set the Reference Divider input and output controls to 100 volts.
8. Set the DC Voltage Standard to approximately 100 volts, then adjust its output for a null reading on the null meter.
9. The 8500A/AE reading displayed is between + 99.997 and + 100.003.
10. Increment the 8500A/AE range manually to 1000 volts.
11. The 8500A/AE reading displayed is between + 99.99 and + 100.01.
12. Set the Reference Divider input and output controls to 1000 volts.
13. Set the DC Voltage Standard to approximately 1000 volts, then adjust its output for a null reading on the null meter.
14. The 8500A/AE reading displayed is between + 999.97 and + 1000.03.
15. Set the DC Voltage Standard to standby.
16. Reverse the leads at the DC Voltage Standard and standard cell terminals (lead previously HI to LO and vice versa).
17. Set the DC Voltage Standard to operate and repeat steps 4 through 17, ensuring that the listed outputs are now negative.

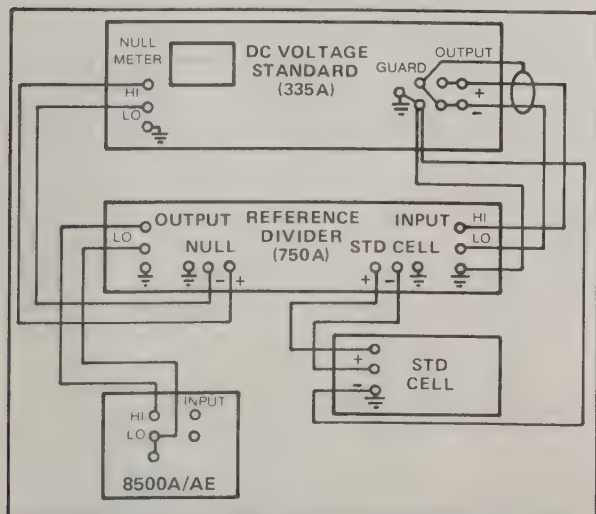


Figure 4-2. Connections For High Range DC Voltage Tests

- 4-33. AUTORANGING TEST
- 4-34. Test the autoranging capability of the 8500A/AE with the following procedure:
 1. Verify that the DC Volts and Autoranging modes are selected on the 8500A/AE.
 2. Connect the 8500A/AE input directly to the DC Voltage Standard output.
 3. Vary the output of the voltage source through its range, checking that the instrument autoranges approximately at the points indicated in Table 4-3.

Table 4-3. Autoranging

8500A/AE CHANGES RANGE		NOMINAL READING
FROM	TO	
100 mV	1 V	312.5 mV
1 V	10 V	2.5 V
10 V	100 V	20 V
100 V	1000 V	160 V
1000 V	100 V	120 V
100 V	10 V	15
10 V	1 V	1.875
1 V	100 mV	0.234375

- 4-35. DC EXTERNAL REFERENCE
- 4-36. Test the DC four wire true ratio, using the following procedure:
 1. Connect the test equipment to the 8500A/AE as shown in Figure 4-3.
 2. Select the VDC function and Autoranging on the 8500A/AE.
 3. Set the DC Voltage Standard controls for + 10.0000 volt output and the Voltage Divider controls to 1.000000.
 4. Depress and hold the EXT REF switch. As long as the switch is held, the 8500A/AE display reads the External Reference input of 10 volts (between 9.9998 and 10.0002).
 5. Release the EXT REF switch. The 8500A/AE computes the ratio (V_{IN}/V_{REF}) and displays a reading between 0.99996 and 1.00004.
 6. Set the Voltage Divider controls to 0.1000000.
 7. The 8500A/AE displays a reading between 99.995 (–3) and 100.005 (–3).
 8. Depress the EXT REF switch to toggle the 8500A/AE out of the External Reference mode.
 9. Remove power from the test equipment and disconnect it from the 8500A/AE.

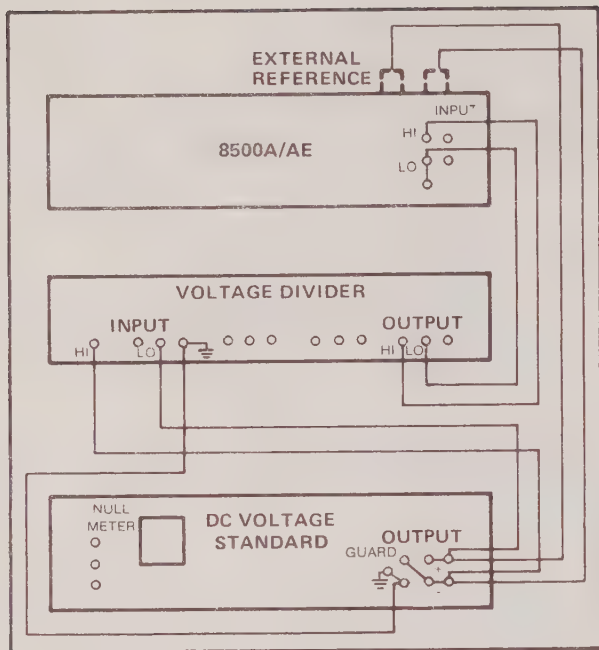


Figure 4-3. DC External Reference Test

4-37. CALIBRATION PROCEDURES

NOTE

The standards called out in the following procedure are required to meet the published specifications. If this accuracy is not required for a particular function (e.g., Resistance, DC Current, etc.), standards with a lower rated accuracy may be used. The accuracy of the 8500A/AE function will then be based on the accuracy of the standard used, rather than the published specifications.

4-38. Introduction

4-39. The 8500A/AE should be calibrated every 90 days or 1 year, as required to meet the applicable accuracy specifications. It should also be recalibrated any time that repairs are made to the instrument. When performing the calibration, the ambient temperature should be $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and the relative humidity should be less than 75%. Refer to Table 4-1 for the recommended test equipment. Check the instruction manuals for the various pieces of test equipment for the correct warmup periods. Power Supply adjustments are shown in Figure 4-4. Adjustments and test points on the remaining pcbs are accessible on the top edge of the board by popping open the hinged module top. Adjustments are labeled on the underside of the module top.

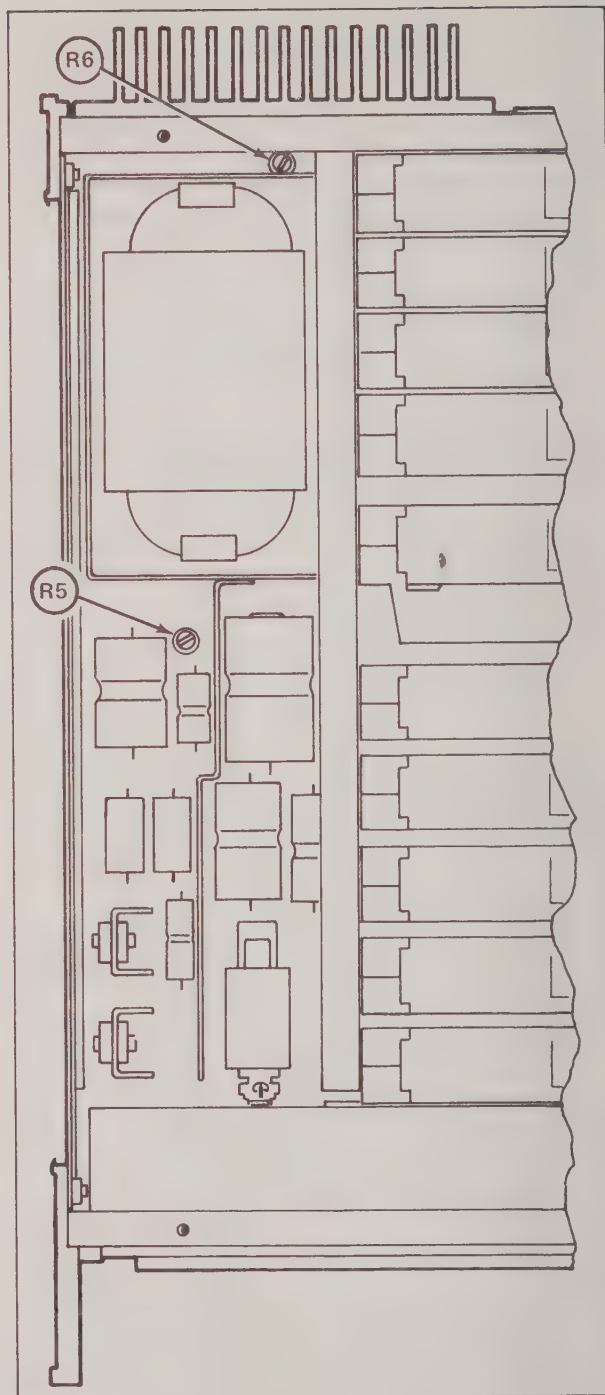


Figure 4-4. Power Supply Adjustments

4-40. Preliminary Operations

4-41. With the POWER switch OFF, replace the Isolator or Bus Interconnect, whichever is installed, with the Bus Interconnect, whichever is installed, with the Bus Interconnect and Monitor pcb assembly MIS-7013K. Remove

the CAL Memory if installed. After completing calibration, reinstall the CAL Memory and enter new calibration factors (should be zeros). Set the POWER switch to ON and allow the instrument to warm up for at least one hour before continuing with the calibration.

4-42. Power Supply

4-43. Perform the Power Supply checks and adjustments as follows:

CAUTION!

Do not use the 8500A/AE to check its own supplies.

1. Connect the test DMM HI input to Vcc on the Bus Interconnect and Monitor pcb and the LO input to Vss.
2. Adjust R6 for a reading between +5.00 and +5.10V dc to set the Logic Supply.
3. Transfer the HI DMM input lead to VA2.
4. Adjust R5 for a reading between +5.00 and +5.10V dc to set the Analog Supply.
5. Verify that the voltages in Table 4-4 are within the prescribed limits.
6. Prepare the test DMM to read AC volts and verify that the voltage between RT5 and Vss reads between 13 and 17V ac.
7. Turn the POWER switch to OFF and remove the Bus Interconnect and Monitor pcb and return the Isolator or Bus Interconnect to the instrument.
8. Reapply power to the 8500A/AE.

Table 4-4. Power Supply Verifications

TEST POINTS		VOLTAGE RANGE (Vdc)		SUPPLY
HIGH	LOW	FROM	TO	
V _{DD}	V _{SS}	+ 11.4	+ 12.6	Logic
V _{GG}	V _{SS}	- 11.4	- 12.6	Logic
VA1	AR	+ 14.25	+ 15.75	Analog
VA2	AR	- 14.25	- 15.75	Analog
VA3	AR	+ 29.7	+ 31.7	Analog
VA4	AR	- 29.7	+ 31.7	Analog

4-44. DC Calibration Procedure

NOTE

If the Calibration Memory (Option 04) is installed, either it or the calibration factors must be removed. To remove these factors:

1. Place CAL switch down.
2. Short the input terminals.
3. Using the UP/DOWN ranging switches, press STORE for each range.

4-45. The offset adjustment, R14, in the Active Filter does not require adjustment unless Q27 or U5 have been replaced. There are no other adjustments in the Active Filter. Refer to troubleshooting, Figure 4-9, in this section for adjustment procedures for R14.

4-46. DC CONDITIONER ADJUSTMENTS

4-47. All adjustments and test points in the following procedures are on the DC Signal Conditioner. Perform the subtest, using the following procedure:

1. Select V DC, the 100 mV range, the slow filter (indicator on), the 2 readings per second sample rate, and the CAL switch ON (CAL indicator illuminated).
2. Select front input terminals.
3. Short the 8500A/AE front input terminals.
4. Adjust R53 for a reading of 0 μ V $\pm$ 0 μ V.
5. Remove the short from the input terminals and apply a 1 M Ω /0.22 μ F parallel load.
6. Adjust R52 for a reading between -0.002 and +0.002V dc (0 $\pm$ 2 μ V).
7. Repeat steps 2 through 5 until both readings are present without an adjustment.

4-48. A/D CONVERTER CALIBRATION PROCEDURES

4-49. Use the following procedures to calibrate the A/D Converter. All test points and adjustments are on the A/D Converter.

4-50. This paragraph contains the adjustment procedure for R64. R64 requires adjustment only if R54 in the tens bit ladder has been replaced during repair. Unless R54 has been replaced, go on to the next paragraph.

1. Connect the test DMM HI to TP7, LO to TP6.
2. Adjust R1 for a test DMM reading of -7.000X V.
3. Remove the test DMM.
4. Using the test connections in Figure 4-1, apply 10.10000 volts dc to the 8500A/AE input terminals.
5. Adjust R64 for an 8500A/AE reading of + 10.10000 $\pm$ 5 cal digits.
6. Continue with the following adjustments.

4-51. A/D Zero Adjustment

1. Select the 10V range on the 8500A/AE.
2. Short the 8500A/AE input terminals.
3. Adjust R8 for a reading of 0.0000-0 $\pm$ 1 cal digit.

4-52. A/D Calibrator Settings

4-53. Prepare the DC Voltage Standard for use during the A/D Calibration using the following procedure:

1. Connect the equipment, as shown with the solid lines in Figure 4-1. Do not connect the 8500A/AE at this time.
2. Set the Voltage Divider controls at one-tenth the standard cell certified value (standard cell value x 0.1).
3. Adjust the DC Voltage Standard output for a null on the null meter.
4. Record the dial setting of the DC Voltage Standard as "Control Setting A." This setting will be used later in the procedure, in addition to the following paragraph.
5. Disconnect the leads at the Voltage Divider output terminals from the null meter and standard cell and connect the 8500A/AE as shown with the broken lines in Figure 4-1.

4-54. A/D Ladder Adjustments

1. Select the 10V manual range on the 8500A/AE.
2. Set the Voltage Divider controls for a ratio of 1.0100000.
3. Adjust R1 for a reading between +10.0999-9 and +10.1000-1 (+10.1000-0 ± 1 cal digit).
4. Reverse the polarity of the dc voltage at the DC Voltage Standard for a negative input to the 8500A/AE.
5. Adjust R2 for a reading between -10.0999-9 and -10.1000-1 (-10.1000-0 ± 1 cal digit). If these adjustments cannot be made, do the adjustments of R64 detailed in paragraph 4-49.
6. Return the polarity of the dc voltage to a positive output from the DC Voltage Standard input at the 8500A/AE.
7. Set the Voltage Divider controls for a ratio of .0500000.
8. Adjust R7 for a reading between +0.4999-9 and +0.5000-1 (+0.5000-0 ± 1 cal digit).
9. Repeat steps 2 through 8 until all readings are within tolerance without making an adjustment.
10. Set the Voltage Divider controls for ratio of .5100000.
11. Adjust R6 for a reading between +5.0999-9 and +5.1000-1 (+5.1000-0 ± 1 cal digit).

12. Set the Voltage Divider controls for a ratio of .2600000.
13. Adjust R5 for a reading between +2.5999-9 and +2.6000-1 (+2.6000-0 ± 1 cal digit).
14. Set the Voltage Divider controls for a ratio of .1400000.
15. Adjust R4 for a reading between +1.3999-9 and +1.4000-1 (+1.4000-0 ± 1 cal digit).
16. Set the Voltage Divider controls for a ratio of .0750000.
17. Adjust R3 for a reading between +0.7499-9 and 0.7500-1 (0.7500-0 ± 1 cal digit).
18. Repeat steps 2 through 17 until all steps are within the stated tolerance.

4-55. Linearity Verification

1. Verify that the 8500A/AE sample rate is set at two readings/second and the 10V manual range is selected.
2. Set the Voltage Divider controls for a ratio of .2000000.
3. Set the DC Voltage Standard for an output of approximately 100 volts and adjust its output for a reading between +19.9999-9 and +20.0000-1 on the 8500A/AE.
4. Set the Voltage Divider controls for a ratio of .0000000 and verify that the reading is between -0.0000-1 and +0.0000-1 (0 ± 1 cal digit).
5. Reverse the polarity of the dc voltage at the DC Voltage Standard for negative input to the 8500A/AE.
6. Verify that the 8500A/AE reads between -0.0000-1 and +0.0000-1 (0 ± 1 cal digit).
7. Return the polarity of the dc voltage output from the DC Voltage Standard to a positive input at the 8500A/AE.
8. Set the Voltage Divider controls to the settings listed in Table 4-5, verifying that the readings are within the tolerances listed in the table.
9. Reverse the polarity of the DC Voltage Standard output and repeat the steps in Table 4-5, checking that the reading is negative and within the listed tolerance.
10. Set the DC Voltage Standard for the "Control Setting A" recorded earlier.

11. Set the Voltage Divider controls for a ratio of 1.0000000.
12. Verify that the 8500A/AE reads between + 9.9999-9 and + 10.0000-1 (+ 10.0000-1 $\pm$ 1 cal digit).

Table 4-5. Linearity Checks

DIVIDER SETTING	READINGS		
	MINIMUM	NOMINAL	MAXIMUM
.0100000	0.9999-5	1.0000-0	1.0000-5
.0200000	1.9999-5	2.0000-0	2.0000-5
.0300000	2.9999-5	3.0000-0	3.0000-5
.0400000	3.9999-5	4.0000-0	4.0000-5
.0500000	4.9999-5	5.0000-0	5.0000-5
.0600000	5.9999-5	6.0000-0	6.0000-5
.0700000	6.9999-5	7.0000-0	7.0000-5
.0800000	7.9999-5	8.0000-0	8.0000-5
.0900000	8.9999-5	9.0000-0	9.0000-5
.1000000	9.9999-5	10.0000-0	10.0000-5
.1100000	10.9999-4	11.0000-0	11.0000-6
.1200000	11.9999-4	12.0000-0	12.0000-6
.1300000	12.9999-4	13.0000-0	13.0000-6
.1400000	13.9999-3	14.0000-0	14.0000-7
.1500000	14.9999-3	15.0000-0	15.0000-7
.1600000	15.9999-3	16.0000-0	16.0000-7
.1700000	16.9999-2	17.0000-0	17.0000-8
.1800000	17.9999-2	18.0000-0	18.0000-8
.1900000	18.9999-2	19.0000-0	19.0000-8
.2000000	19.9999-2	20.0000-0	20.0000-8

4-56. RANGE ADJUSTMENTS

NOTE

If the Calibration Memory option is included with the unit, refer to Section 6 for reinstallation and setup.

4-57. All adjustments and test points in the following procedure are on the DC signal conditioner. Perform the subtests using the following procedures.

4-58. 100 mV Range Adjustments

1. Ensure that the DC Voltage Standard is set for "Control Setting A."
2. Set the Voltage Divider controls for a ratio of .0000000.
3. Select the 100 mV range on the 8500A/AE.
4. If required, readjust R53, for a reading of $0 \pm 0 \mu\text{V}$.
5. Set the Voltage Divider controls for a ratio of .0300000.
6. Adjust R49 for a reading between +299.999 and +300.001 (+300.000 $\pm$ 1 digit).

4-59. 1V Range Adjustments

1. Select the 1V range on the 8500A/AE.
2. Set the Voltage Divider controls for a ratio of .2500000.
3. Adjust R48 for a reading between +2.49999-9 and +2.50000-1 (+2.50000-1 $\pm$ 1 cal digit).

4-60. 100V Range Adjustments

1. Connect the equipment as shown in Figure 4-2.
2. Select the 100V range on the 8500A/AE.
3. Set the Reference Divider Standard Cell voltage controls to the standard cell certified value and both the input and output controls to 100 volts.
4. Set the DC Voltage Standard to approximately 100 volts, then adjust its output for a null on the null meter.
5. Adjust R47 for a reading between +99.999-9 and 100.000-1 (+100.000-0 $\pm$ 1 cal digit).

4-61. 1000V Range Adjustments

1. Select the 1000V range on the 8500A/AE and take the instrument out of the Cal mode by moving the CAL switch to OFF (CAL indicator extinguishes).
2. Verify that the 100 volt setting on the Reference Divider is still nulled.
3. The 8500A/AE should read between +99.98 and +100.02 (+100.00 $\pm$ 2 digits).
4. Set the Reference Divider input and output controls to 500 volts.
5. Set the DC Voltage Standard to approximately 500 volts, then adjust its output for a null on the null meter.
6. The 8500A/AE should read between +499.98 and +500.02 (+500.00 $\pm$ 2 digits).
7. Set the Reference Divider input and output controls to 1000 volts.
8. Set the DC Voltage Standard to approximately 1000 volts, then adjust its output for a null on the null meter.
9. The 8500A/AE should read between +999.98 and +1000.02 (1000.00 $\pm$ 2 digits).

4-62. TROUBLESHOOTING

4-63. Static discharge can damage components contained in the 8500A/AE. The following precautions should be observed during troubleshooting, repair, or module replacement.

1. Never connect or disconnect modules or components without first turning the 8500A/AE's Power switch to OFF.
2. Perform all repairs at a static-free work station.
3. Minimize handling of IC's and pcb's; in no case handle them by their connectors.
4. Keep repair parts in their original containers until ready for use.
5. Use static ground straps to discharge repair personnel.
6. Use conductive foam or anti-static containers to store replacement or removed IC's and pcb's.
7. Remove all plastic, vinyl and styrafoam products from the work area.
8. Do not slide static sensitive devices over any surface.
9. Use only anti-static type solder removal tools.
10. Use grounded tip soldering irons.

4-64. A procedure for isolating faulty modules is contained in Table 4-6. It is important that the theory of operation given in Section 3 be read before attempting to troubleshoot the 8500A/AE. The module isolation procedure involves making observations of the 8500A/AE behavior, then removing or replacing modules to establish cause-effect relationships. DO NOT remove or replace modules with the power on. Follow the procedure step by step all the way through to assure that the fault is isolated to the correct module. Faults in some modules may cause apparent faults in other modules.

CAUTION

If the Isolator and the Bit Serial Asynchronous interface are installed, replacement of the isolator by the Bus Interconnect Monitor pcb may allow a hazardous common mode voltage to appear on the output connector of the interface.

4-65. Figures 4-5 through 4-11 contain symptom analysis troubleshooting information for each of the modules and pcb's contained in the mainframe 8500A/AE. The possible failures are listed in order of probability. Troubleshooting information for optional modules is contained in Section 6.

4-66. Troubleshooting Notes

4-67. Error codes are disabled in the CAL mode. Selection of a function for which the module is either faulty or missing will then result in random readings. Random readings will also be seen if the REAR INPUT switch is improperly positioned.

4-68. In using the Bus Interconnect Monitor pcb, note that RT1 physically does not extend to the Isolator-Interconnect slot. RT1 is accessible with the Monitor pcb installed in any of the first four slots (J11A, B, C, or D). The outputs of the optional Ohms Converter and Current Shunts modules are on RT1.

4-69. DO NOT apply an input directly to the A/D Converter module. Damage to the A/D Converter may result. The DC Signal Conditioner may be bypassed by applying a signal directly to the Active Filter module, as outlined in the module isolation procedure.

4-70. Module Disassembly

4-71. All modules in the 8500A/AE are mounted in shielded cases which may be disassembled, using the following procedure. Avoid using excessive force to prevent breaking the plastic.

1. Pop open the lid by using the indentations at either end and lifting up. Hinge the lid back.
2. Orient the module with one of the guides up.
3. Press down on the end of the case half above the words "OPEN" while pulling up lightly on the lip of the module guide and just separate that end.
4. Repeat step 3 for the other end.
5. Open the top of the module and the bottom catch will automatically come apart.
6. Press down on the top of the pcb while pulling out to free the pcb from the case half.

4-72. Use the following procedure for module re-assembly.

1. Insert the pcb in the case half bottom first and lightly press down on the top to snap it in place.
2. Ensure that the spring shield connection is not caught behind the pcb.
3. Align the bottom center catch of the case halves, making sure the shields at either end fit together properly.
4. Close the two halves together, snapping the module guides closed.
5. Using a small screwdriver or similar tool, lift the spring shield connection so that it rests on the shield opposite.

4-73. Troubleshooting Aids

4-74. The Static Controller (MIS-7190K) and the Test Module (MIS-7191K) are valuable troubleshooting aids for the 8500A/AE. Further information concerning these troubleshooting aids is available from any Sales Office.

Table 4-6. Faulty Module Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1.	Turn the power ON. The following should be displayed. HI 1.0.Y (Y=Program number) then C XXXXX (X = installed option number) then 0.00 ± 0.05 (DC Volts, 1000V range, Fast sample rate)		
2.	Is the display blank?	6	3
3.	Is the initial display other than HI 1.0.0?	42	4
4.	Is the reading other than 0.00 ± 0.05	59	5
5.	Are the first three displays normal?	78	2
	DISPLAY BLANK AT POWER ON		
6.	Remove bus interconnect (or Isolator if installed).		
7.	Turn power ON. Is HI 1.0.0 displayed?	8	11
8.	Was the isolator installed?	9	11
9.	Install interconnect-monitor in the Isolator slot. Is HI 1.0.0 displayed?	10	13
10.	Bad Isolator. Go to Section 6 under Isolator.		
11.	Is the power indicator on?	17	12
12.	Check the fuse. Is it bad (replace)?	1	17
13.	Remove Cal Memory and remote interfaces if installed. Is HI 1.0.0 displayed?	14	17
14.	Replace Cal Memory. Is HI 1.0.0 displayed?	16	15
15.	Bad Cal Memory. Go to Section 6 under Calibration Memory.		
16.	Bad Remote Interface. Go to Section 6 under the appropriate interface.		
17.	Install the interconnect-monitor PCB in the Isolator slot.		
18.	Check power supply voltages as follows. Test DMM Common to VSS. V _{DD} = +11.4 to +12.6 V _{CC} = +5.15 to 5.25 V _{GG} = -11.4 to -12.6 LINE = 13V ac to 17V ac		
19.	Are the power supplies within tolerance?	26	20
20.	Remove all modules except the Front Panel.		
21.	Recheck power supplies. Within tolerance?	22	23
22.	Replace modules one at a time (start with Controller), rechecking supplies after replacing each module. The last one put in when the supplies go bad is the rotten egg. Go to the appropriate figure for that module.		
23.	Remove the front panel. Recheck supplies. Within tolerance?	25	24
24.	Problem on power supply, motherboard, or power supply interconnect.		
25.	Bad Front Panel. Go to Figure 4-7.		

Table 4-6. Faulty Module Isolation (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
26.	Remove Cal Memory and the remote interface if installed.		
27.	Check IC 6, 5, 1, 0 on interbus. All moving?	28	30
28.	Check ACK line. Moving?	29	30
29.	Check ID0 -7. All moving?	32	30
30.	Check Controller clock, TP2, TP3 (TP1 = gnd). Is 12V, 1.7 MHz signal present?	33	31
31.	Bad Controller. Go to Figure 4-6.		
32.	Bad Front Panel. Go to Figure 4-7.		
33.	Remove analog modules, leaving only Controller, Front Panel, and Interconnect. Is the display normal?	34	35
34.	Faulty Analog Module. Replace one at a time — last one in is the rotten egg. Go to the appropriate figure for that module		
35.	Remove Front Panel, replace DC Signal Conditioner, Filter, A/D Converter.		
36.	Check IC lines, ACK line, ID lines. All moving?	38	37
37.	Bad Controller. Go to Figure 4-6.		
38.	Bad Front Panel. Go to Figure 4-7.		
	INITIAL DISPLAY OTHER THAN HI 1.0.0		
39.	Remove Interconnect PCB (or Isolator if installed).		
40.	Apply power. Is the display as follows? HI 1.0.0 C XXXXX Error 9	41	44
41.	Was the Isolator installed?	42	47
42.	Install Interconnect-monitor PCB in Isolator slot. Is display normal?	43	48
43.	Bad Isolator. Go to Section 6.		
44.	Are Cal Memory or remote interface installed?	45	47
45.	Remove Cal Memory and remote. Display normal?	46	47
46.	Replace one at a time. Go to appropriate figure.		
47.	Install Interconnect-Monitor PCB.		
48.	Check for shorts between the IC and the ID lines. Shorts?	49	51
49.	Remove all modules except Front Panel. Removed short?	50	57
50.	Reinstall modules one at a time (start with Controller), checking for shorts between modules. Last one in is the rotten egg. Go to the figure for the appropriate module.		

Table 4-6. Faulty Module Isolation (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
51.	Are any of the IC, ID, or ACK lines always high or always low?	53	52
52.	Remove all modules except Front Panel and Controller. IC and ID moving?	56	53
53.	Remove Front Panel. Reinstall dc analog modules if removed.		
54.	Are the IC, ID, and ACK lines moving?	57	55
55.	Bad Controller. Go to Figure 4-6.		
56.	Is the display normal?	58	57
57.	Front Panel bad. Go to Figure 4-7.		
58.	Faulty Analog module. Replace one at a time until symptoms recur. Last one in is faulty. Go to the figure for the appropriate module		
READING NOT ZERO AT TURN ON			
59.	Remove all optional modules (except Isolator if installed), leaving Controller, (Isolator), DC Signal Conditioner, Filter, A/D, Front Panel.		
60.	Apply power. Is the reading zero?	61	62
61.	Replace modules one at a time until reading is not zero. Last one in is the rotten egg. Go to Section 6.		
62.	Is the Isolator installed?	63	65
63.	Replace Isolator with Interconnect-Monitor PCB. Is the reading zero?	64	65
64.	Bad Isolator. Go to Section 6.		
65.	Install Interconnect Monitor if not already installed. Check supply voltages as follows. Test DMM LO on AR (analog return). $\begin{array}{ll} \text{VA1} = +14.25 \text{ to } +15.75 \text{ V} & \text{VA4} = -29 \text{ to } -32 \text{ V} \\ \text{VA2} = -14.25 \text{ to } -15.75 \text{ V} & \text{V}_{\text{CC}} = -15 \text{ V} \\ \text{VA3} = +29 \text{ to } +32 \text{ V} & \text{V}_{\text{SS}} = -20 \text{ V} \end{array} \left. \begin{array}{l} \\ \\ \end{array} \right\} \begin{array}{l} \text{Difference must equal} \\ 4.9 \text{ to } 5.2 \text{ V} \end{array}$		
66.	Supply voltages in tolerance?	70	67
67.	Remove all modules except Front Panel. Supplies in tolerance?	69	68
68.	Repair power supply. Go to Figure 4-5.		
69.	Replace modules one at a time, checking supplies between modules. Last one in is faulty. Go to the appropriate figure.		
70.	Remove Filter module. CAL switch on. Select DC Volts, 1000V range.		
71.	Is the reading zero?	72	77
72.	Replace Filter module; remove DC Signal Conditioner.		
73.	Place a jumper (short) between RT2 and RT6.		
74.	Is the reading zero (disregarding CAL digit)?	75	76

Table 4-6. Faulty Module Isolation (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
75.	DC Signal Conditioner bad. Go to Figure 4-8.		
76.	Filter module bad. Go to Figure 4-9.		
77.	A/D converter bad. Go to Figure 4-10.		
78.	Do the Performance Tests earlier in this section.		
79.	Is the unit within the tolerances given?		80
80.	Is the Cal Memory installed?	81	83
81.	Remove the Cal Memory. Is the unit now within tolerance?	82	83
82.	Faulty Cal Memory. Go to Section 6.		
83.	Is the Isolator installed?	84	87
84.	Replace Isolator with Interconnect-monitor PCB.		
85.	Is unit within tolerance?	86	87
86.	Bad Isolator. Go to Section 6.		
87.	Is the failure in DC Volts Performance Test?	89	88
88.	Go to Section 6 for the appropriate faulty function.		
89.	Remove all optional modules, leaving Front Panel, Controller, DC Signal Conditioner, Active Filter, and A/D Converter.		
90.	Do the DC Volts Performance Test. Is the unit within tolerance?	91	92
91.	Reinstall options one at a time, rechecking DC Volts tolerance. Last module installed when unit becomes out of tolerance is faulty. Go to Section 6.		
92.	Check supply voltages according to the following chart. VA1 = +14.25 to +15.75V VA4 = -29 to -32V VA2 = -14.25 to -15.75V V _{CC} = -15V) VA3 = +29 to +32V V _{SS} = -20V) Difference = 4.9 to 5.2V		
93.	Are the supplies within tolerance?	97	94
94.	Remove all modules except Controller and Front Panel. Are the voltages correct?	95	96
95.	Replace modules one at a time until the voltages go bad. Last one in is the rotten egg. Go to the appropriate figure.		
96.	Repair power supply. Go to Figure 4-5.		

Table 4-6. Faulty Module Isolation (cont)

STEP NO.	ACTION	Go to the step number given for correct response																																													
		YES	NO																																												
97.	Connect the test DMM LO to RT2 and HI to RT6. Apply known voltages to the 8500A/AE input to test the DC Signal Conditioner. The following voltages are suggested inputs: <table> <tr> <th>8500A RANGE</th><th>GAIN DC SIG COND</th><th>INPUT</th><th>TEST DMM READING</th></tr> <tr> <td>100mV</td><td>X64</td><td>2mV</td><td>128.0mV</td></tr> <tr> <td>100mV</td><td>X64</td><td>200 mV</td><td>12.80V</td></tr> <tr> <td>1V</td><td>X8</td><td>125mV</td><td>1.0V</td></tr> <tr> <td>1V</td><td>X8</td><td>2V</td><td>16.0V</td></tr> <tr> <td>10V</td><td>X1</td><td>1V</td><td>1.0V</td></tr> <tr> <td>10V</td><td>X1</td><td>19V</td><td>19.0V</td></tr> <tr> <td>100V</td><td>÷8</td><td>1V</td><td>125.0mV</td></tr> <tr> <td>100V</td><td>÷8</td><td>140V</td><td>17.50V</td></tr> <tr> <td>1000V</td><td>÷64</td><td>64V</td><td>1.0V</td></tr> <tr> <td>1000V</td><td>÷64</td><td>960V</td><td>15.0V</td></tr> </table>	8500A RANGE	GAIN DC SIG COND	INPUT	TEST DMM READING	100mV	X64	2mV	128.0mV	100mV	X64	200 mV	12.80V	1V	X8	125mV	1.0V	1V	X8	2V	16.0V	10V	X1	1V	1.0V	10V	X1	19V	19.0V	100V	÷8	1V	125.0mV	100V	÷8	140V	17.50V	1000V	÷64	64V	1.0V	1000V	÷64	960V	15.0V		
8500A RANGE	GAIN DC SIG COND	INPUT	TEST DMM READING																																												
100mV	X64	2mV	128.0mV																																												
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100V	÷8	1V	125.0mV																																												
100V	÷8	140V	17.50V																																												
1000V	÷64	64V	1.0V																																												
1000V	÷64	960V	15.0V																																												
98.	Are the readings correct (noise or drift in the DC Signal Conditioner will show up on the Test DMM readings)?	100	99																																												
99.	DC Signal Conditioner faulty. Go to Figure 4-8.																																														
100.	Connect Test DMM HI to RT5. Repeat table in step 97. The test DMM readings should be the same.																																														
101.	Are the Test DMM readings the same?	103	102																																												
102.	Faulty Active Filter module. Go to Figure 4-9.																																														
103.	Faulty A/D Converter. Go to Figure 4-10.																																														

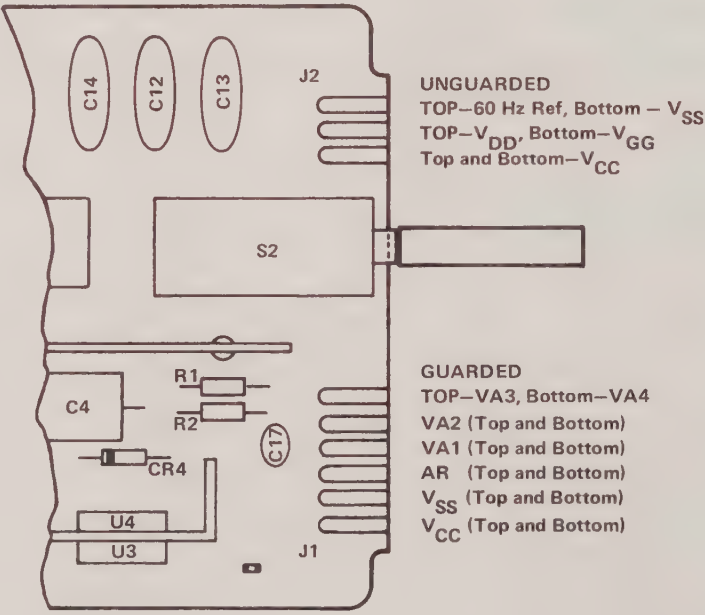
SYMPTOM	POSSIBLE FAILURE
GUARDED SUPPLY	
VA1 – BAD	U3, BR2, or Transformer
(+15V). Noisy	C3, BR2
VA2 – BAD	U4, BR2, or Transformer
(–15V) Noisy	C4, BR2
VA3 – BAD	U2, CR4, BR1, Transformer
(+30V) Noisy	C2, BR1
VA4 – BAD	U1, CR3, BR1, Transformer
(–30V) Noisy	C1, BR2
V _{CC} (Guarded)	U5, R5, R3, C5, CR1, CR2, Transformer
VA1 and VA2 are used as a reference for VA3 and VA4. VA3 and VA4 could load down VA1 and VA2. Check by lifting the reference diodes CR3 and CR4.	
UNGUARDED SUPPLY	
V _{DD} (+12V)	U6, C6, C9, C12, BR3, Transformer
V _{GG} (–12V)	U7, C13, C10, C7, BR3, Transformer
V _{CC} (+5V)	U8, R6, R4, C8, C13, C11, BR4, Transformer
The drawing below identifies the pins at the power supply edge connector. Input voltages to the regulators should be approximately 5V higher than the normal output voltages. If the output is higher or lower than specified and noise is not the problem, the regulator is bad.	
	

Figure 4-5. Power Supply Troubleshooting

NOTE

Due to the speed and complexity of the controller, it is recommended that, when a problem is isolated to the controller, the unit be sent to the nearest Service Center for repair. The following information will assist in troubleshooting simpler problems. Many problems require the use of a Trender or similar tester.

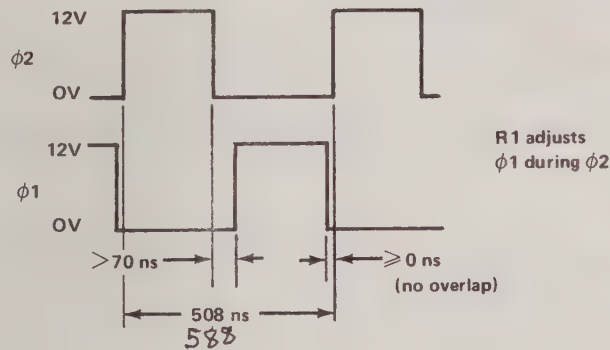
SYMPTOM

POSSIBLE FAILURE

Troubleshoot the Controller with only the Controller, Front Panel, and Power Supply installed.

Blank Display (most common symptom of controller failure) Proceed with checks listed below

1. Check $\phi 1$ and $\phi 2$ clock at TP2, TP3



$\phi 1$ bad, $\phi 2$ ok	U3, U9, U10
$\phi 1$ ok, $\phi 2$ bad	U9, U10
$\phi 1$, $\phi 2$ bad	U3, U9, Y1
$\phi 1$ won't adjust	R1, U3, U9, capacitors

2. Check RST (reset) line (at U10-12, U35-13)

High? Check for 400 μ sec delay on +5V at U36-13

Stuck Low? U35, U34, U36, U38

3. Check RDT (ready) line (at U10-23, U1-9)

Pulsing — OK

Always low clock pulse at U1-12 U1, U16, U15, U8—
check inputs to U8, U18

Always high ACK interrupt or mark interrupt not
functioning properly

Figure 4-6. Controller Troubleshooting

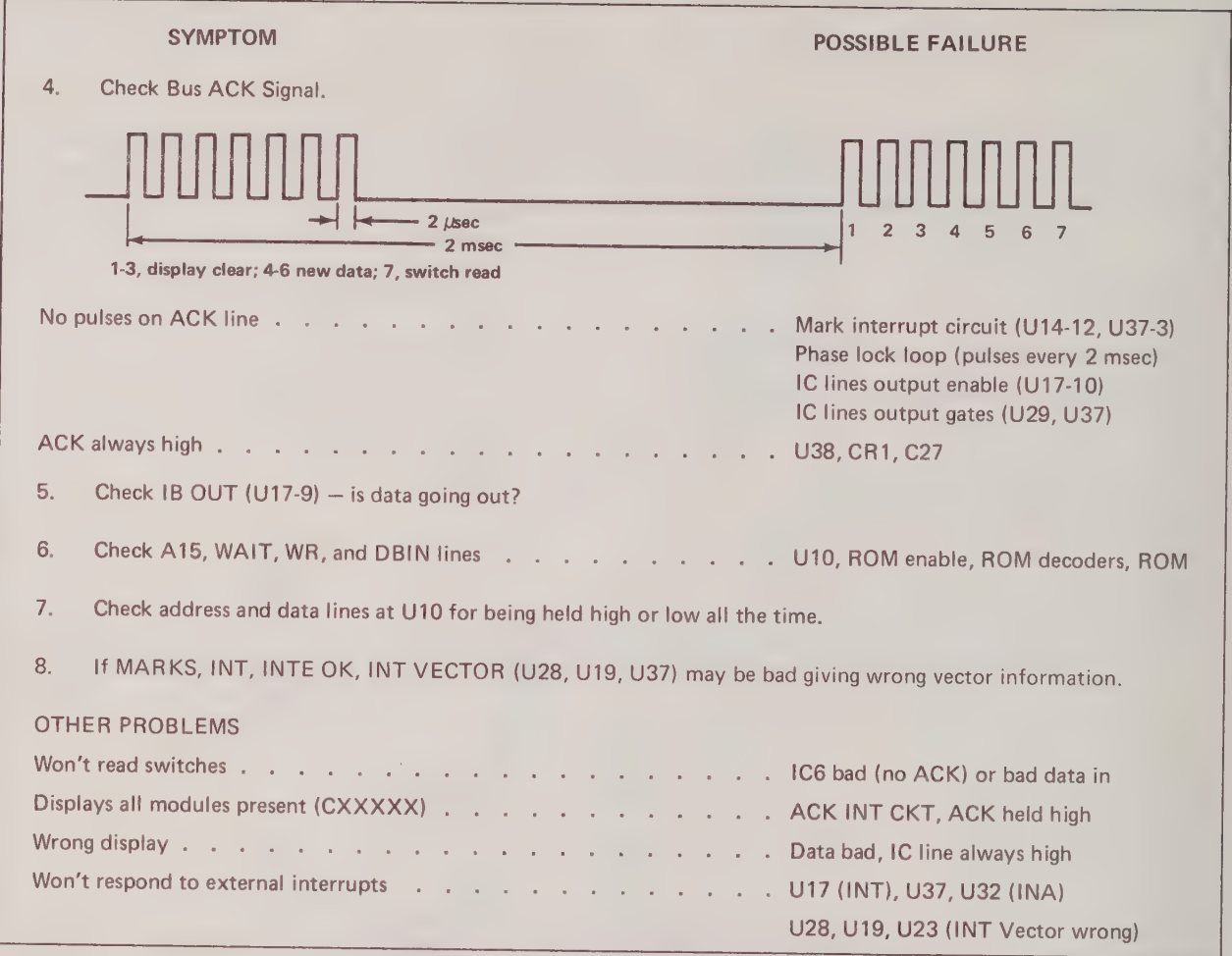


Figure 4-6. Controller Troubleshooting (cont)

SYMPTOM	POSSIBLE FAILURE
No ACK Pulse	U28, U19 (Address Decoders) U23 (Indirect F/F) U19, U11, Q10 (ACK Circuit)
No Display (ACK Pulse Present)	U18 (Kill Circuit)
No Response to Switch Pushes (Display Good)	Switch Associated With Function U32, CR1 — CR4 Open
Segment Bad In All LEDs	Check Path from Latch to Transistor Drivers to LED Cathodes
One LED Doesn't Light	Check Path From Latch To Inverter to Transistor Drivers to LED Anode
Segment or Decimal Missing On Only One LED	Bad LED
Display Gives Wrong Numbers, One LED Brighter	U11 (Reset to Indirect Address F/F, U23) Address Decoder. (Problem is Indicative of Front Panel Responding to an Invalid Address.)

Figure 4-7. Front Panel Troubleshooting

SYMPTOM

POSSIBLE FAILURE

DC Inoperative All Ranges	Digital Control Logic Q8, Q6, Q7, Open K1, Q1, Q2 Open; Q18, Q19, U3 Bad
Display Blanks	U1 or U2
Locks in Overrange	U3
Reading Drifts	U4; Q14, Q15, Q16 Leaky
Won't Zero	U5 or U6
100 mV Range Bad	Q31, Q32, Q14
1V and 100V Range Bad	Q33, Q34, Q15
100V and 1000V Range Bad	K2, Q3, Q4
Random Readings	K1 Open, K2 Shorted
Nonlinear Readings	Q16, Q15, Q14 Leaky

ADDRESS AND DATA FIELD

ADDRESS

IB DATA DURING ADDRESS

IC4, IC3, IC0 = 1	ID3	ID2	ID1	ID0	
	0	1	1	0	100 mV Range G = 64
	1	0	1	0	1V Range G = 8
	1	1	0	1	10V Range G = 1
	1	0	0	0	100V Range G = ÷8 (÷64 x 8)
	1	1	0	0	100V Range G = ÷64

ID3 - ID4 = Control Amplifier Gain

0	1	= x 64
1	0	= x 8
1	1	= z 1

RT1 inputs controlled as follows for OHMS & ADC

ADDRESS

DATA

IC4, IC3, IC0 = 1	ID3	ID2	ID1	ID0	
	0	1	0	1	G = x 64
	1	0	0	1	G = x 8
	1	1	0	1	G = x 1

NOTE

If R54 - R57, Q18, Q19 or Q22 are replaced it will be necessary to return the module to the factory (attn. PARTS) to be temperature compensated anew.

Figure 4-8. DC Signal Conditioner Troubleshooting

SYMPTOM	POSSIBLE FAILURE
High Zero Offset	Q32, Q25, Q19, Q20 Shorted
DC Inoperative	Q18 Open — Q21, Q22, Q23, Q24 Open Q27, U5 Digital Logic
Overrange	U5 — Q19, Q20 Shorted
Noisy	
All Ranges	
Either Filter	Q25, Q32 Leaky — Q31, U5 Bad
Slow Filter (ON)	Q21, Q22 Leaky — U4 Bad
Fast Filter (OFF)	Q23, Q24 Leaky — U3 Bad
Nonlinear Readings	U5
Display Blanks	U1 Or U2

ADDRESS AND DATA FIELD

ADDRESS	DATA
IC4, IC3, & IC1 = 1	ID0 = 1 Filter By Pass (Remote Only) ID1 = 1 Z Filter (F.P. Light On) ID2 = 1 Y Filter (F.P. Light Off) ID3 = 1 Filter - Always on except In Ext. Ref. ID4 = 1 Ext. Ref. Lo ID5 = 1 Ext. Ref. Hi

Adjustment of R14

1. Short the 8500A/AE input terminals.
2. Short RT6 to RT2 on the Bus Interconnect Monitor.
3. Adjust R14 for a reading of $\pm .000000 \pm 2$ digits. (This requires that the A/D Converter is working accurately.)

Selection of R15 or R16.

If Q27 or U5 have been replaced, R15 and R16 will require reselection if adjustment of R14 does not zero the reading.

1. Only one of R15 and R16 will be installed. Replace whichever is installed with a short.
2. Connect the R15 short to the R16 short.
3. Short RT6 to RT2 on the Bus Interconnect Monitor.
4. Connect the test DMM HI to TP3 and LO to TP1 on the Active Filter module.
5. Select a resistor from the table below according to the measured offset. If the polarity is positive, install the resistor as R16; if negative as R15. (Maximum allowable offset in this step is 5200 μ V.)

OFFSET (μ V)	RESISTOR	JOHN FLUKE PART NO.
0-400	None	
401-1200	31.6K	261610
1201-2000	63.4K	235382
2001-2800	97.6K	241380
2801-3600	133.0K	289074
3601-4400	165.0K	376186
4401-5200	205.0K	375931

6. After installing the resistor, adjust R14.

Figure 4-9. Active Filter Troubleshooting

DIGITAL BOARD

SYMPTOM

POSSIBLE FAILURE

Display Blanks	U33, U34, U35 (Affecting ID Lines)
Improper Readings, Inoperative A/D, Nonlinear Readings	Check Transistor Array Outputs to J1 and J2 — The Rise and Fall Times of These Switching Pulses Must be $< 2 \mu\text{sec}$.
Flickering Display	Autozero Control — U25, U34
Direct Address	
IC 4, 3, & 2 High	ID0 = 1 = Reset Counter ID1 = 1 = Auto Zero ID2 = 0 = Buffer Input ID2 = 1 = Remainder Input ID3 = 1 = Channel X (Auto Zero and Remainders 1 and 3) ID3 = 0 = Channel Y (Remainders 2 and 4)
Indirect Address	
IC 2 & 1 High (and Ring Counter Not in C0 Time period, C0 = 0)	This Indirect Address allows the ID7 Enable to bring back Polarity Bits to the Controller Module

ANALOG BOARD

First Check TP5 — Should be switching between + and $-7V$. Typical failures in this circuit result in a portion of the switching slope having a slew rate less than $1V/\mu\text{sec}$. A glitch at the zero point is normal.

SYMPTOM

POSSIBLE FAILURE

Noisy Readings	U1, U2, U3
Nonlinear Ladder	U4, Q9, Q10 (Q27)
Ladder Out Of Tolerance	FETS Q11 — Q15 or Q17 — Q21
All Digits Wrong	U7, Q31, Q32
Reading Locked (Doesn't Respond To Input Change) Or Always Overrange	U4, Q9, U1, U2, U3, Q2, Q3
Bad Remainders (Lesser Digits)	Q22, U4, U6
No Polarity Bit Returned	Q29, Q28
Shifty Readings (Most Or All Digits)	Autozero Settling Time Problems U8, Q30 — Q8, Q7

NOTE

If U1, R9, R14-R16, R34, R35, R50-55, R67, Q1-Q3, Q11-Q16, Q25, or Q26 are replaced it will be necessary to return the module to the factory (attn. PARTS) to be temperature compensated anew.

Figure 4-10. R² A/D Converter Troubleshooting

Section 5

List of Replaceable Parts

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5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the mainframe instrument. A parts breakdown for each of the optional modules is contained in the subsection of Section 6 pertaining to the module. Components are listed alpha-numerically by assembly. Both electrical and mechanical components are listed first by reference designation and second by item number. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

- 1. Reference Designation or Item Number.
- 2. Description of each part.
- 3. FLUKE Stock Number.
- 4. Federal Supply Code for Manufacturers. (See Appendix A for Code-to-Name list.)
- 5. Manufacturer's Part Number or Type.
- 6. Total Quantity per assembly or component.
- 7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

8. Use Code is provided to identify certain parts that have been added, deleted, or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity, paragraph 5-7.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

- 1. Quantity.
- 2. FLUKE Stock Number.
- 3. Description.
- 4. Reference Designation or Item Number.
- 5. Printed Circuit Board Part Number.
- 6. Instrument Model and Serial Number.

5-7. USE CODE EFFECTIVITY LIST

USE CODE	SERIAL NUMBER EFFECTIVITY
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Indicated devices are subject to damage by static discharge.

Table 5-1. Final Assembly 15 Inch Pack

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	FINAL ASSY 15 INCH PACK (8500A/AE-5001) FIGURE: 5-1	ORDER	MODEL	8500A/AE	1		
A2	MOTHER BOARD PCB ASSY (8500A-4001T)	459628	89536	459628	1		
A3	BUS INTERCONNECT PCB ASSY (MIS-4081)	459636	89536	459636	1		
A4	POWER SUPPLY PCB ASSY (8500A-4031T)	448860	89536	448860	1		
A5	PWR SUP INTERCONNECT ASSY (8500A-4032)	401760	89536	401760	1		
A6	⊗CONTROLLER, PCB ASSY (MIS-4185T)	384107	89536	384107	1		
A7	⊗FRONT PANEL ASSY (8500A/AE-4021T)	472621	89536	472621	1		
A8	⊗DC SIGNAL COND PCB ASSY (MIS-4100T)	383901	89536	383901	1		
A9	⊗ACTIVE FILTER PCB ASSY (MIS-4130T)	383976	89536	383976	1		
A10	⊗FAST RR A/D CONV PCB ASSY (MIS-4140T)	383984	89536	383984	1		
A11	INPUT SWITCH ASSY (8500A/AE-4414)	472589	89536	472589	1		
A12	REAR INPUT ASSY (8500A/AE-4413)	472571	89536	472571	1		
E1	POST. BINDING, HEAD GRNDING	225615	20584	3575	1		
E2	POST. BINDING, GRNDING	225623	20584	3576	1		
H1	NUT, HEX, DOUBLE CHAMFER 1/4-28	110619	89536	110619	1		
H2	SHORTING LINK	190728	83330	21171	3		
H3	SCREW, FH UNDERCUT, 6-32 X 1/4	320093	89536	320093	6		
H4	SCREW, CAP, LO HEAD SOCKET #8	295105	74445	8-32UNRC	4		
H5	SCREW, FHP, COUNTERSUNK	114116	73734	20264	8		
H6	SCREW, PHP, SEMS, 6 - 32 X 3/8	177022	89536	177022	2		
H7	SCREW, PHP, 4-40 X 1/4	129882	73734	19022	11		
H8	SCREW, FH, UNDERCUT, 6-32 X 1/4	320093	89536	320093	6		
H9	SCREW, PNA, 8 - 32 X 5/8	293324	73734	23067	2		
H10	SCREW, PHP, SEMS, 6 - 32 X 1/2	177030	89536	177030	8		
H11	SCREW, FHP, COUNTERSINK 8 - 32 X 1/2	114355	73734	18266	4		
H12	WASHER, LOCK, INT TOOTH #8	110320	73734	1305	2		
H13	WASHER, LOCK, INT TOOTH, #1/4	110817	73734	1308	1		
MP1	BAIL, FULL WIDTH	231407	89536	231407	1		
MP2	BEZEL, I/O	416206	89536	416206	1		
MP3	BUTTON, PWR SWITCH	401646	89536	401646	1		
MP4	CHASSIS ASSY	383414	89536	383414	1		
MP5	CHANNEL, RUBBER	103622	83478	896	5		
MP6	CONTACT STRIP	370619	30817	97-500-A	.75		
MP7	CORNER, FINISHED	350009	89536	350009	2		
MP8	CORNER, HANDLE	394304	89536	394304	2		
MP9	COVER, BOTTOM	383265	89536	383265	1		
MP11	COVER TOP	383257	89536	383257	1		
MP12	DECAL, REAR PANEL	473587	89536	473587	1		
MP13	DECAL, SIDE TRIM, FWD	295386	89536	295386	1		
MP14	DECAL, CORNER	394387	89536	394387	4		
MP15	DECAL, HANDLE TRIM	436832	89536	436832	2		
MP16	DECAL, FRONT PANEL	413351	89536	413351	1		
MP17	DECAL, SERIAL NO.	393957	89536	393957	1		
MP18	EXTRUSION, PCB RETAINER	408476	89536	408476	1		
MP19	FOOT, BAIL STAND	292870	89536	292870	4		
MP20	FOOT, REAR PANEL	307363	89536	307363	2		
MP21	HOLDER, INSTRUCTION BOOK	427534	89536	427534	1		
MP22	INSERT, FRONT PANEL	475103	89536	475103	1		
MP23	INSTRUCTION PAGE ASSY	475434	89536	475434	1		
MP24	LENS DISPLAY	383380	89536	383380	1		
MP25	PUSH BUTTON, STAMPED	473603	89536	473603	1		
P1	PLUG, SWITCH	437855	89536	437855	1		
W1	CABLE, EXTERNAL REFERENCE	472597	89536	472597	1		
W2	CABLE, FRONT INPUT	472563	89536	472563	1		

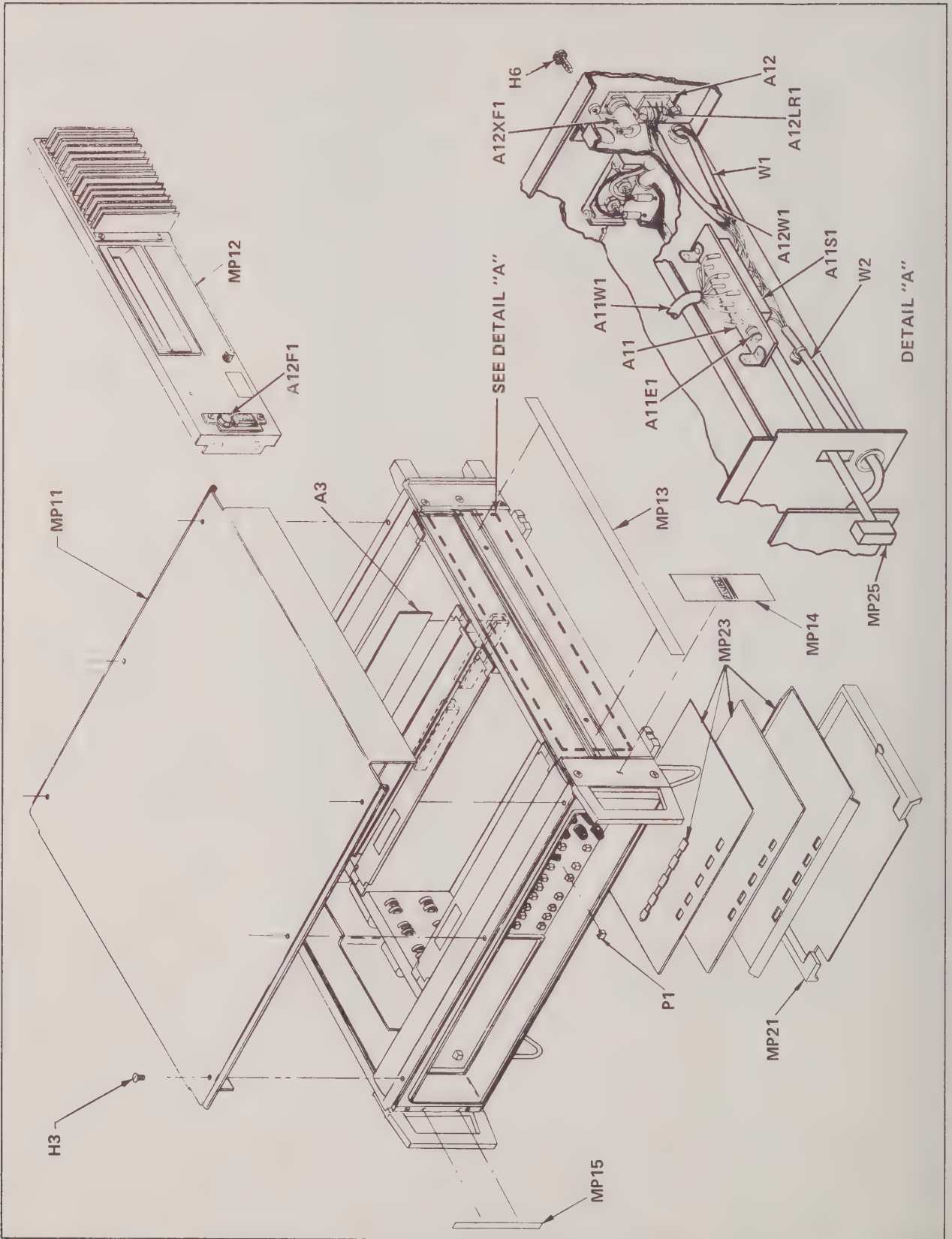


Figure 5-1. Final Assembly 15 Inch Pack

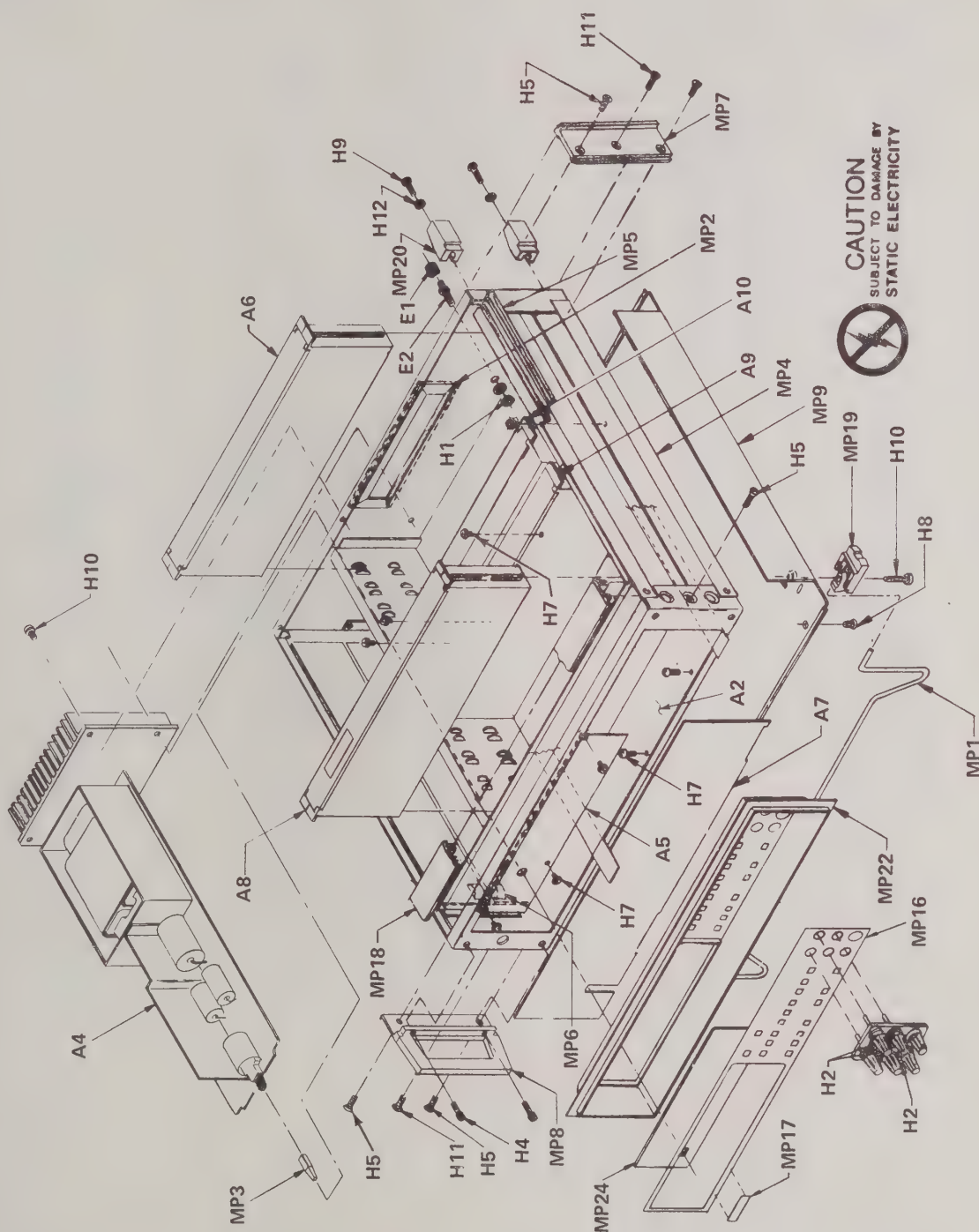


Figure 5-1. Final Assembly 15 Inch Pack (cont)

Table 5-2. A2 Motherboard PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2	MOTHERBOARD PCB ASSY (8500A-4001) FIGURE: 5-2	459628	89536	459628	1		
H1	NUT, HEX DOUBLE CHAMFER	184044	73734	8002A-NP	2		
H2	SCREW, PHP, 4-40X1	157008	73734	19030	2		
H3	WASHER, FLAT #4	146225	86926	5710-18-32	2		
H4	WASHER, LOCK, INT TOOTH	110403	73734	99402	2		
J2	CONNECTOR, BD EDGE RECPT, 18 PIN	291906	00779	583650-3	1		
J6	CONNECTOR, BD EDGE RECPT, 20 PIN	291914	00779	583650-4	1		
J7	CONNECTOR, BD EDGE RECPT, 8 PIN	354951	00779	583407-5	1		
J8	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550	6		
J11A	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	12		
J11B	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	REF		
J11C	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	REF		
J11D	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	REF		
J12A	CONNECTOR, BD EDGE RECPT, 6 PIN	291625	00779	583650-1	4		
J12B	CONNECTOR, BD EDGE RECPT, 6 PIN	291625	00779	583650-1	REF		
J12C	CONNECTOR, BD EDGE RECPT, 6 PIN	291625	00779	583650-1	REF		
J12D	CONNECTOR, BD EDGE RECPT, 6 PIN	291625	00779	583650-1	REF		
J21G	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	REF		
J22H	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	REF		
J23H	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	REF		
J27	CONNECTOR, BD EDGE RECPT, 10 PIN	403964	00779	583407-6	1		
J28	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550	REF		
J29K	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	REF		
J30K	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	REF		
J31A	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550	REF		
J31B	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550	REF		
J31C	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550	REF		
J31D	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550	REF		
J31L	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	REF		
J31M	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	REF		
J31N	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	REF		
J41	BINDING POST, BLK	275560	32767	820-45	1		
J42	BINDING POST, RED	275552	32767	820-65	1		
MP1	TERMINAL BLOCK	419663	89536	419663	1		
R3	RES, COMP, 1K +/-5%, 1/4W	148023	01121	C81025	1		
R4	RES, COMP, 5.6M +/-5%, 2W	169821	01121	H85655	1		
XJ2	POLARIZING INSERT	293498	00779	530030-1	14		
XJ6	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ11A	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ11B	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ11C	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ11D	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ21G	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ22H	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ23H	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ27	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ29K	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ31L	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ31M	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ31N	POLARIZING INSERT	293498	00779	530030-1	REF		

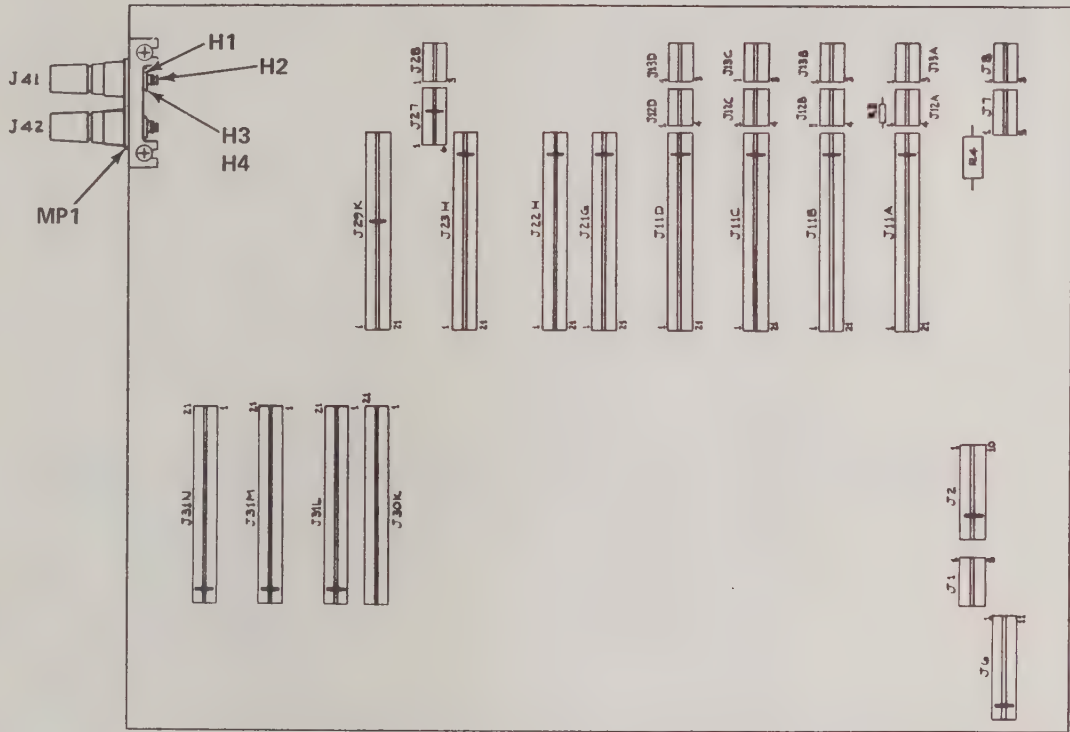


Figure 5-2. A2 Motherboard PCB Assembly

Table 5-3. A3 Bus Interconnect PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	BUS INTERCONNECT PCB ASSY (MIS-4081) FIGURE: 5-3	459636	89536	459636	1		
C1	CAP, TA, 220UF +/-20%, 6V	408682	56289	196D227X-0006TE4	2		
C2	CAP, TA, 220UF +/-20%, 6V	408682	56289	196D227X-0006TE4	REF		
CR1	DIODE, SI, RECT, 1 AMP	343491	01295	1N4002	1		

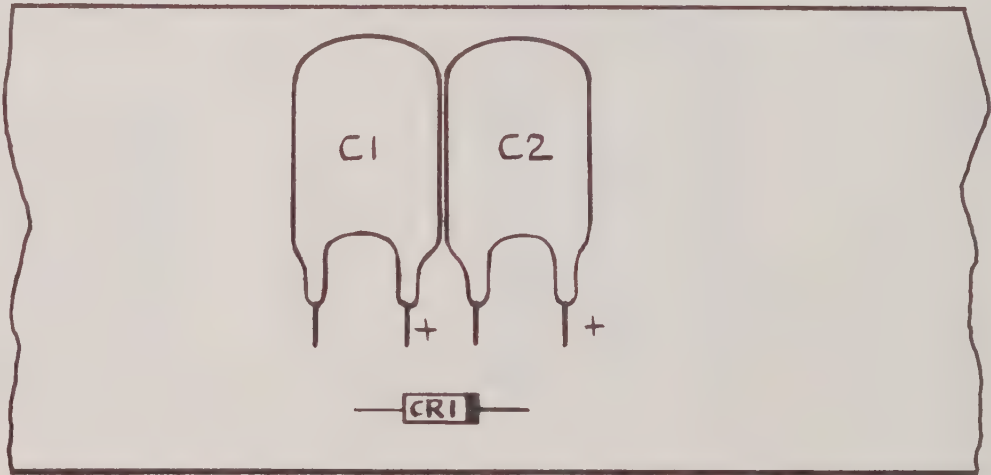


Figure 5-3. A3 Bus Interconnect PCB Assembly

Table 5-4. A4 Power Supply Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A4	POWER SUPPLY ASSY (8500A-4031)						
	POWER SUPPLY ASSY, 115/230V MODEL	448860	89536	448860	REF		
	POWER SUPPLY ASSY, 100V MODEL	456988	89536	456988	REF		
	FIGURE: 5-4						
BR1	BRIDGE RECTIFIER	296509	09423	FB200	4	1	
BR2	BRIDGE RECTIFIER	296509	09423	FB200	REF		
BR3	BRIDGE RECTIFIER	296509	09423	FB200	REF		
BR4	BRIDGE RECTIFIER	296509	09423	FB200	REF		
C1	CAP. ELECT. 470UF -10/+50%, 40V	185868	73445	ET471Z040-A02	2	1	
C2	CAP. ELECT. 470UF -10/+50%, 40V	185868	73445	ET471Z040-A02	REF		
C3	CAP. ELECT. 220UF -10/+50%, 40V	178616	80031	ET221X040-A01	2	1	
C4	CAP. ELECT. 220UF -10/+50%, 40V	178616	80031	ET221X040-A01	REF		
C5	CAP. ELECT. 2200UF -10/+100%, 25V	448126	12674	61C25BAS-252	2	1	
C6	CAP. ELECT. 4000UF -10/+100%, 25V	370734	99372	3044TS043U025	1	1	
C7	CAP. ELECT. 2200UF -10/+100%, 25V	448126	12674	61C25BAS-252	REF		
C8	CAP. ELECT. 15000UF -10/+100%, 15V	407940	99372	3044HA1534015	1	1	
C9	CAP. TA. 5.6UF +/-20%, 25V	368969	56289	196D565X-0025KA1	4		
C10	CAP. TA. 5.6UF +/-20%, 25V	368969	56289	196D565X-0025KA1	REF		
C11	CAP. TA. 5.6UF +/-20%, 25V	368969	56289	196D565X-0025KA1	REF		
C12	CAP. CER. 0.1UF +/-20%, 100V	149146	56289	33C4186	3		
C13	CAP. CER. 0.1UF +/-20%, 100V	149146	56289	33C4186	REF		
C14	CAP. CER. 0.1UF +/-20%, 100V	149146	56289	33C4186	REF		
C15	CAP. CER. 0.005 +/-20%, 3KV	188003	71590	2DDH6R502M	2		
C16	CAP. CER. 0.005 +/-20%, 3KV	188003	71590	2DDH6R502M	REF		
C17	CAP. TA. 5.6UF +/-20%, 25V	368969	56289	196D565X-0025KA1	REF		
CR1	DIODE, RECT. SI, 50V	347559	05277	1N5400	3	1	
CR2	DIODE, RECT. SI, 50V	347559	05277	1N5400	REF		
CR3	DIODE, RECT. SI, 100V	343491	14099	SI-1	2	1	
CR4	DIODE, RECT. SI, 100V	343491	01295	1N4002	REF		
CR5	DIODE, RECT. SI, 50V	347559	05277	1N5400	REF		
F1	FUSE, SLO BLD, 1/2 AMP	109322	71400	MDL1-2	1	5	
H1	NUTPLATE (NOT SHOWN)	420448	89536	420448	1		
J1	CONNECTOR, POWER RECEPTACLE	284166	82389	EAC301	1		
MP1	DECAL (NOT SHOWN)	386250	89536	386250	1		
MP2	EXTRUSION (NOT SHOWN)	416974	89536	416974	1		
MP3	FERRITE CORE (NOT SHOWN)	420588	89536	420588	1		
MP4	INSULATOR, POWER SWITCH (NOT SHOWN)	383153	89536	383153	1		
MP5	INSULATOR, SEMICONDUCTOR MTG (NOT SHOWN)	428821	55285	7403-10-51	5		
MP6	INSULATOR GASKET (NOT SHOWN)	436824	89536	436824	1		
R1	RES. COMP. 3.3K +/-5%, 1/4W	148056	01121	CB3325	2		
R2	RES. COMP. 3.3K +/-5%, 1/4W	148056	01121	CB3325	REF		
R3	RES. COMP. 490 +/-5%, 1/4W	147975	01121	CB3915	2		
R4	RES. COMP. 490 +/-5%, 1/4W	147975	01121	CB3915	REF		
R5	RES. VAR. CERMET. 50 +/-20%, 1/2W	320861	02111	62-1-1-500	2	1	
R6	RES. VAR. CERMET. 50 +/-20%, 1/2W	320861	02111	62-1-1-500	REF		
S1	SWITCH, SLIDE, DPDT (115/230V)	376798	82389	11A1437	1	1	
S2	SWITCH, POWER	291526	89536	291526	1	1	
T1-1	XFMR, HEADER ASSY (115/230V)	450403	89536	450403	1		
T1-2	XFMR, HEADER ASSY (100V)	456350	89536	456350	1		
U1	IC, LIN. VOL REG	413187	04713	MC7015CP	2	1	
U2	IC, LIN. NEG. VOL REG	413179	04713	MC7915CP	2	1	
U3	IC, LIN. VOL REG	413187	04713	MC7815CP	REF		
U4	IC, LIN. NEG. VOL REG	413179	04713	MC7915CP	REF		
U5	IC, LIN. VOL REG	355107	04713	MC7805CP	1	1	
U6	IC, LIN. VOL REG	428854	04713	MC7812CP	1	1	
U7	IC, LIN. NEG. VOL REG	381665	04713	MC7912CP	1	1	
U8	IC, LIN. VOL REG	428847	04713	MC7805CP	1	1	
XF1	FUSEHOLDER	435628	89536	435628			
XU1	HEAT DISSIPATOR (U1,U2) NOT SHOWN	414128	13103	60308-TT	2		
XU2	HEAT DISSIPATOR (U1,U2) NOT SHOWN	414128	13103	60308-TT	2		
XU3	HEATSINK (U5) NOT SHOWN	386235	13103	6032D	1		
XU4	SOCKET, IC (NOT SHOWN)	402958	27264	10-18-2031	3		
XU5	SOCKET, IC (NOT SHOWN)	402958	27264	10-18-2031	REF		
XU6	SOCKET, IC (NOT SHOWN)	402958	27264	10-18-2031	REF		

5-10

Table 5-5. A5 Power Supply Interconnect Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5	PWR SUP INTERCONNECT ASSY (8500A-4032) FIGURE:5-1	401760	89536	401760	1		
P1	CONNECTOR, BD EDGE, RECPT	291625	00779	583650-1	1		
P2	CONNECTOR, BD EDGE, RECPT	352682	00779	583694-2	1		

Table 5-6. A6/A6A1 Controller PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A6	⊗CONTROLLER ASSEMBLY (8500A-4185T) FIGURE:5-5	384107	89536	384107	1		
A6A1	⊗CONTROLLER PCB ASSEMBLY						
MP1	CASE, HALF, MODULE	402990	89536	402990	2		
MP2	CASE, COVER MODULE (NOT SHOWN)	402974	89536	402974	1		
MP3	DECAL (NOT SHOWN)	413542	89536	413542	1		
MP4	CLAMP, NYLON STRAP (NOT SHOWN)	172080	06383	SST1M	1		
MP5	GUARD, FRONT (NOT SHOWN)	383356	89536	383356	1		
MP6	GUARD, REAR (NOT SHOWN)	383364	89536	383364	1		
MP7	SHIELD, COVER (NOT SHOWN)	440008	89536	440008	1		
U7	⊗IC DCTL, MOS (SEE FINAL ASSY)	473108	89536	473108	1	1	
U10	⊗IC DCTL, MOS, CPU (SEE FINAL ASSY)	404541	01295	TMS8080	1	1	
U22	⊗IC, DCTL MOS (SEE FINAL ASSY)	473090	89536	473090	1	1	
U25	⊗IC, DCTL MOS (SEE FINAL ASSY)	473074	89536	473074	1	1	
U33	⊗IC DCTL, MOS (SEE FINAL ASSY)	473082	89536	473082	1	1	
A6A1	⊗CONTROLLER PCB ASSEMBLY FIGURE:5-5						
C1	CAP, MICA, 15PF +/-5%, 500V	148569	72136	DM15C150J	1		
C2	CAP, MICA, 47PF +/-5%, 500V	148536	72136	DM15E470J	1		
C3	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	15		
C4	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C5	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C6	CAP, CER, 0.022UF -20/+100%, 40V	358325	72982	8121-A050-651-223Z	2		
C7	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C8	CAP, MICA, 4PF +/-0.5PF, 500V	190397	72136	DM15C040E	2		
C9	CAP, MICA, 4PF +/-0.5PF, 500V	190397	72136	DM15C040E	REF		
C10	CAP, CER, 1UF +/-20%, 50V	436782	51642	300-050-601-105M	1		
C11	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C12	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C13	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C14	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C15	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C16	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C17	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C18	CAP, TA, 15UF +/-20%, 6V	161935	56289	196D156X-0006-KA1	1		
C19	CAP, CER, 0.22UF +/-20%, 50V	309849	71590	CW30C224K	1		
C20	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C21	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C22	CAP, ELECT, TA, 1UF +/-5%, 15V	461152	56289	150D106X-5015A2	1	1	
C23	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C24	CAP, MICA, 33PF +/-5%, 500V	160317	72136	DM15E330J	2		
C25	CAP, TA, 39UF +/-20%, 6V	163915	56289	196D396X-0006	1		
C26	CAP, CER, 220PF +/-10%, 500V	268425	72982	851-000-Z5R-222K	1		
C27	CAP, MICA, 33PF +/-5%, 500V	160317	72136	DM15E330J	REF		
C28	CAP, CER, 0.022UF -20/+100%, 40V	358325	72982	8121-A050-651-223Z	REF		
C29	CAP, TA, 2.2UF +/-20%, 20V	161927	56289	196D225X-0020HA1	3		
C30	CAP, TA, 2.2UF +/-20%, 20V	161927	56289	196D225X-0020HA1	REF		
C31	CAP, TA, 2.2UF +/-20%, 20V	161927	56289	196D225X-0020HA1	REF		
C32	CAP, CER, 10.000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C33	CAP, TA, 150UF +/-20%, 6V	460204	56289	183DR157X0006F	1		
CR1	DIODE, HI SPEED, SWITCHING	203323	07910	1N4448	1		
R1	RES, VAR, CERMET, 10K +/-10%, 1/2W	285171	89536	285171	1	1	

Table 5-6. A6/A6A1 Controller PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R2	RES. COMP. 100K +/-5%, 1/4W	148189	01121	CB1045	4		
R3	RES. COMP. 4.7K +/-5%, 1/4W	148072	01121	CB4725	6		
R4	RES. COMP. 2K +/-5%, 1/4W	202879	01121	CB2025	4		
R5	RES. COMP. 6.8K +/-5%, 1/4W	148098	01121	CB6825	2		
R6	RES. COMP. 10M +/-5%, 1/4W	194944	01121	CB1065	1		
R7	RES. COMP. 2K +/-5%, 1/4W	202879	01121	CB2025	REF		
R8	RES. COMP. 4.7K +/-5%, 1/4W	148072	01121	CB4725	REF		
R9	RES. COMP. 4.7K +/-5%, 1/4W	148072	01121	CB4725	REF		
R10	RES. COMP. 4.7K +/-5%, 1/4W	148072	01121	CB4725	REF		
R11	RES. COMP. 4.7K +/-5%, 1/4W	148072	01121	CB4725	REF		
R12	RES. COMP. 10K +/-5%, 1/4W	148106	01121	CB1035	3		
R13	RES. COMP. 10K +/-5%, 1/4W	148106	01121	CB1035	REF		
R14	RES. MF. 715 +/-1%, 1/8W	313080	91637	MFF1-87150F	1		
R15	RES. MF. 523 +/-0.5%, 1/8W	294835	91637	MFF1-85230D	1		
R16	RES. COMP. 4.7K +/-5%, 1/4W	148072	01121	CB4725	REF		
R17	RES. COMP. 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R18	RES. MTL FILM. 23.2K +/-1%, 1/8W	291351	91637	CMF552322F	1		
R19	RES. COMP. 2K +/-5%, 1/4W	202879	01121	CB2025	REF		
R20	RES. COMP. 10K +/-5%, 1/4W	148106	01121	CB1035	REF		
R21	RES. COMP. 6.8K +/-5%, 1/4W	148098	01121	CB6825	REF		
R22	RES. COMP. 3K +/-5%, 1/4W	193508	01121	CB3025	1		
R23	RES. COMP. 680K +/-5%, 1/4W	188433	01121	CB6845	1		
R24	RES. COMP. 1.5K +/-5%, 1/4W	148031	01121	CB1525	1		
R25	RES. COMP. 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R26	RES. COMP. 30K +/-5%, 1/4W	193417	01121	CB3035	1		
R27	RES. COMP. 2K +/-5%, 1/4W	202879	01121	CB2025	REF		
R28	RES. COMP. 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
RN1	RES NETWORK	412916	89536	412916	2	1	
RN2	RES NETWORK	412916	89536	412916	REF		
RN3	RES NETWORK	412924	89536	412924	1	1	
U1	IC, DGTL TTL LPS. DUAL J-K FF	412999	01295	SN74LS109N	1	1	
U2	⊗IC, DGTL, C-MOS, HEX BUFFER/INVERTERS	381830	02735	CD4050AE	1	1	
U3	⊗IC DGTL CMOS FAST QUAD 2 INPUT NAND GATE	413211	07263	34011PC4011PC	1	1	
U5	⊗IC DGTL, MOS 1024 BIT STATIC RAM	404558	34649	P2111A-4	4	1	
U6	⊗IC DGTL, MOS 1024 BIT STATIC RAM	404558	34649	P2111-1	REF		
U8	IC DGTL, TTL, AND-OR INVERT GATES	412981	01295	SN74LS51	1	1	
U9	⊗IC DGTL, C-MOS, HEX INVERTER	404699	12040	MM74C04N	1	1	
U12	⊗IC DGTL, MOS 1024 BIT STATIC RAM	404558	34649	P2111-1	REF		
U13	⊗IC DGTL, MOS 1024 BIT STATIC RAM	404558	34649	P2111-1	REF		
U14	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	04713	MC14013CP	2	1	
U15	IC DGTL TTL QUAD 2 INPUT POS AND GATES	393066	01295	SN74LS08	1	1	
U16	IC DGTL TTL HEX INVERTER POS NAND GATES	393058	01295	SN74LS04	2	1	
U17	⊗IC DGTL C-MOS, QUAD 2 INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U18	IC DGTL TTL HEX/QUAD TYPE D FLIP FLOP	393207	01295	SN74LS174N	1	1	
U19	⊗IC DGTL CMOS STROBED HEX INVERTER/BUFFER	408211	04713	MC14502CP	2	1	
U20	IC DGTL TTL MULTIPLEXER	393165	01295	SN74LS139N	1	1	
U21	IC DGTL TTL HEX INVERTER POS NAND GATES	393058	01295	SN74LS04	REF		
U23	⊗IC DGTL CMOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N	3	1	
U24	⊗IC DGTL CMOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N	REF		
U26	⊗IC LIN CMOS, PLL	403584	02735	CD4046AE	1	1	
U27	⊗IC DGTL, CMOS, QUAD 2 INPUT OR GATE	408393	02735	CD4071BE	1	1	
U28	⊗IC DGTL CMOS 8-BIT PRIORITY ENCODER	412973	02735	CD4523BE	1	1	
U29	⊗IC DGTL CMOS STROBED HEX INVERTER/BUFFER	408211	04713	MC14502CP	REF		
U30	⊗IC DGTL CMOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N	REF		
U31	IC DGTL TTL POS NAND GATES/INVERTERS	393074	01295	SN74LS10N	1	1	
U32	⊗IC DGTL, CMOS, HEX INVERTER	404681	02735	CD4069BE	1	1	
U34	⊗IC DGTL, CMOS, DUAL UP COUNTER	355164	04713	MC14520CL/CP	1	1	
U35	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	04713	MC14013CP	REF		
U36	⊗IC DGTL CMOS MONOSTABLE MV	454017	04713	MC14538BCP	1	1	
U37	⊗IC DGTL, CMOS QUAD 2 INPUT NOR GATES	429944	02735	CD4001BE	1	1	
U38	⊗IC DGTL, CMOS, QUAD 2 INPUT NAND	404632	02735	CD4039BE	1	1	
XU1	SOCKET, IC, 18 PINS (NOT SHOWN)	418228	91506	318-AG39D	6		
XU2	SOCKET, IC, 24 PINS (NOT SHOWN)	418970	91506	324-SG39D	3		
XU3	SOCKET, IC, 40 PINS (NOT SHOWN)	418988	91506	340-AG39D	1		
XU4	SOCKET, IC, 9 PINS (NOT SHOWN)	436774	30035	33-109-1-09	1		
XU5	SOCKET, IC, 12 PINS (NOT SHOWN)	417733	30035	SS-109-1-12	2		
Y1	CRYSTAL, QUARTZ	412932	89536	412932	1		

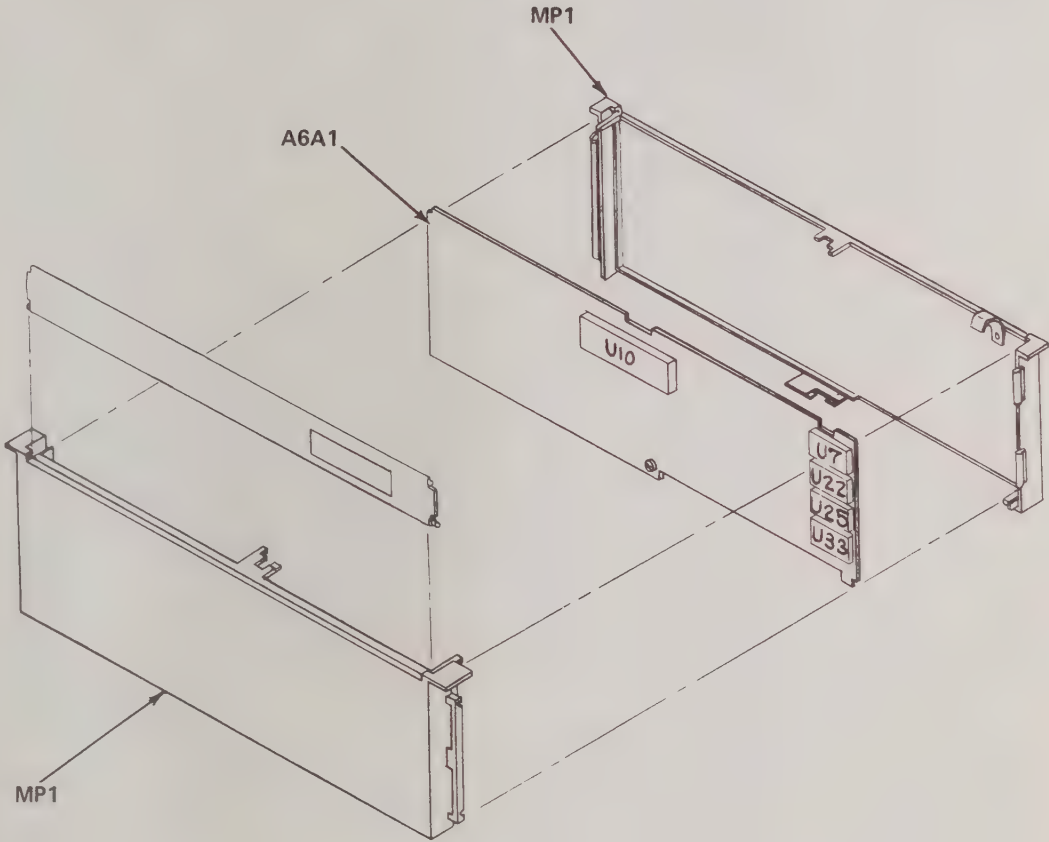


Figure 5-5. A6/A6A1 Controller PCB Assembly

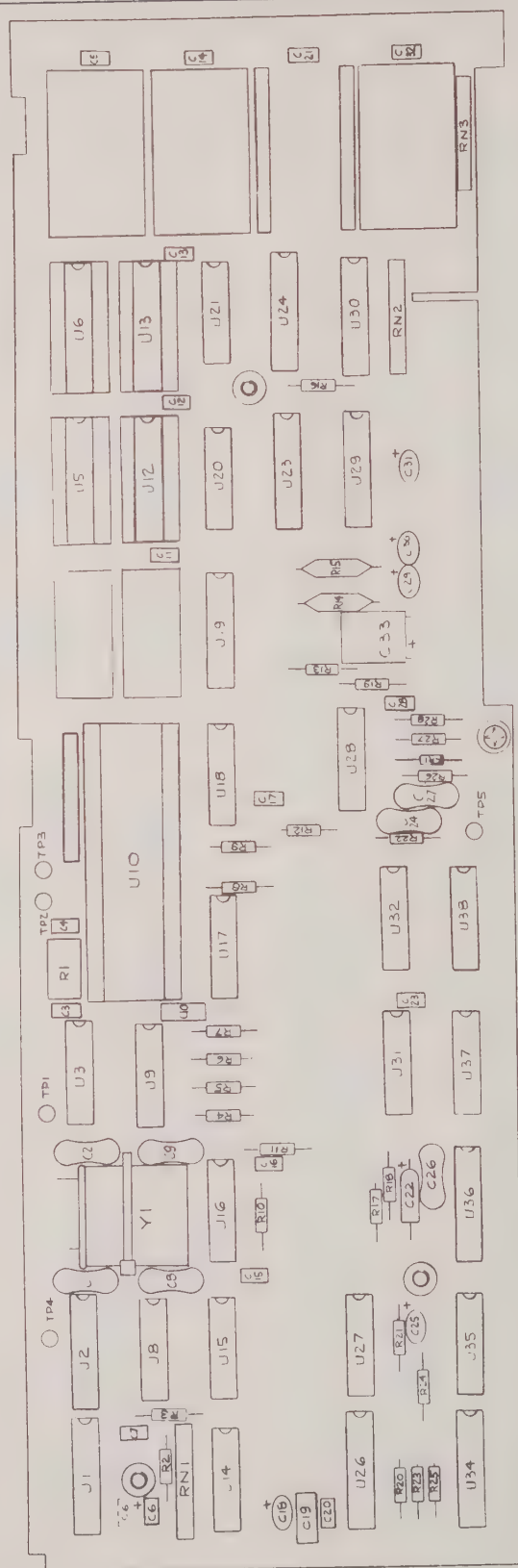


Figure 5-5. A6/A6A1 Controller PCB Assembly (cont)

Table 5-7. A7 Display PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A7	① DISPLAY PCB ASSY (8500A/AE-4021)	472621	89536	472621	1		
	FIGURE: 5-6						
C1	CAP. CER. 0.22UF +/-20%, 50V	309849	71590	CU30C224K	1		
C2	CAP. TA. 5.6UF +/-20%, 25V	368969	56289	196D565X0025KA1	1		
C3	CAP. CER. 1200PF +/-20%, 100V	358283	80031	2222-630-01-122	1		
CR1	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	4	1	
CR2	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR7	DIODE, LED	413831	29083	MV5153	1	1	
E1	SPARK GAP (NOT SHOWN)	442731	25088	B1C145	1		
F1	FUSE, FAST-BLO	109330	71400	AGC11-2	2	5	
H1	SPACER (NOT SHOWN)	446641	11897	167-PB-0588	1		
H2	INSULATING BINDING POST (NOT SHOWN)	449363	89536	449363	1		
J1	BINDING POST, RED	275552	32767	820-65	2		
J2	BINDING POST, RED	275552	32767	820-65	REF		
J3	BINDING POST, BLK	275560	32767	820-45	2		
J4	BINDING POST, BLK	275560	32767	820-45	REF		
J5	BINDING POST, BLUE	275578	32767	820-55	1		
L1	COIL ASSEMBLY	438325	89536	438325	1		
MP1	CAP. FUSE (NOT SHOWN)	455857	89536	455857	1		
MP2	MASK, LED (NOT SHOWN)	418996	89536	418996	4		
MP3	SHIELD, FRONT PANEL (NOT SHOWN)	433524	89536	433524	1		
P1	CONNECTOR PIN	233411	00779	60599-3	6		
Q1	TRANSISTOR, SI, NPN	330803	04713	MPS6560	1	1	
Q2	TRANSISTOR, SI, PNP	340026	04713	MPS6563	7	2	
Q3	TRANSISTOR, SI, PNP	340026	04713	MPS6563	REF		
Q4	TRANSISTOR, SI, PNP	340026	04713	MPS6563	REF		
Q5	TRANSISTOR, SI, PNP	340026	04713	MPS6563	REF		
Q6	TRANSISTOR, SI, PNP	340026	04713	MPS6563	REF		
Q7	TRANSISTOR, SI, PNP	340026	04713	MPS6563	REF		
Q8	TRANSISTOR, SI, PNP	340026	04713	MPS6563	REF		
Q10	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1	1	
R1	RES. COMP. 62 +/-5%, 1/4W	261842	01121	CB6205	1		
R2	RES. COMP. 200 +/-5%, 1/4W	193482	01121	CB2015	2		
R3	RES. COMP. 100K +/-5%, 1/4W	148189	01121	CB1045	1		
R4	RES. COMP. 150 +/-5%, 1/4W	147934	01121	CB1515	1		
R5	RES. COMP. 4.7K +/-5%, 1/4W	148072	01121	CB4725	1		
R6	RES. COMP. 200 +/-5%, 1/4W	193482	01121	CB2015	1		
R8	RES. COMP. 10M +/-5%, 1/4W	194944	01121	CB1065	REF		
S1	SWITCH ASSEMBLY				1		
	SWITCH ACTUATOR	412106	89536	412106	17		
	SWITCH TOP COVER	401299	89536	401299	17		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	17		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	17		
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307	8		
S2	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307	REF		
S3	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307	REF		
S4	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307	REF		
S5	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307	REF		

Table 5-7. A7 Display PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
S6	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, DK PUTTY GREY	406728	89536	406728	6		
S7	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, DK PUTTY GREY	406728	89536	406728	REF		
S8	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, DK PUTTY GREY	406728	89536	406728	REF		
S9	SWITCH, SLIDE, SPDT	417287	95146	MSS-104D-1	1		
S10	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, MED YELLOW	419937	89536	419937	2		
S11	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, MED YELLOW	419937	89536	419937	REF		
S12	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, DK PUTTY GREY	406728	89536	406728	REF		
S13	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, DK PUTTY GREY	406728	89536	406728	REF		
S14	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, DK PUTTY GREY	406728	89536	406728	REF		
S15	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307	REF		
S16	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307	REF		
S17	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307	REF		

Table 5-7. A7 Display PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
S18	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	REF		
	SWITCH TOP COVER	401299	89536	401299	REF		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	REF		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	REF		
	SWITCH, PUSHBUTTON, BLUE	406736	89536	406736	1		
U1	IC, LIN, NPN, TRANSISTOR ARRAY	407866	02735	CA3081	3	1	
U2	⊗ IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	1	1	
U3	⊗ IC, C-MOS, HEX D FLIP FLOP	404509	12040	MM74C174N	3	1	
U4	DISPLAY, LED	453282	29083	MAN4630A	2	1	
U5	DISPLAY SET	440016	89536	440016	1	1	
U6	DISPLAY SET	440016	89536	440016	REF		
U7	DISPLAY SET	440016	89536	440016	REF		
U8	DISPLAY SET	440016	89536	440016	REF		
U9	DISPLAY SET	440016	89536	440016	REF		
U10	DISPLAY SET	440016	89536	440016	REF		
U11	⊗ IC, DCTL, C-MOS, QUAD, 2 INPUT NAND GATE	355198	02735	CD4011AE	1	1	
U12	DISPLAY, LED	453282	29083	MAN4630A	REF		
U13	DISPLAY SET	440016	89536	440016	REF		
U14	DISPLAY, LED	453274	29083	MAN4610A	4	1	
U15	DISPLAY, LED	453274	29083	MAN4610A	REF		
U16	⊗ IC, C-MOS, DUAL, FLIP FLOP	340117	04713	MC14013CL	3	1	
U17	RES NETWORK 4.7K	344069	89536	344069	2	1	
U18	⊗ IC, DIG CMOS, RETRIGGERABLE/RESETTABLE	393512	04713	MC14528CP	1	1	
U19	⊗ IC, CMOS, DUAL 4INPUT NAND GATE	355206	04713	MC14012CP	1	1	
U20	RES NETWORK 4.7K	344069	89536	344069	REF		
U21	IC, LIN, NPN, TRANSISTOR ARRAY	407866	02735	CA3081	REF		
U22	⊗ IC, C-MOS, DUAL, FLIP FLOP	340117	04713	MC14013CL	REF		
U23	⊗ IC, C-MOS, DUAL, FLIP FLOP	340117	04713	MC14013CL	REF		
U24	DISPLAY, LED	453274	29083	MAN4610A	REF		
U25	IC, LIN, NPN, TRANSISTOR ARRAY	407866	02735	CA3081	REF		
U26	DISPLAY, LED	453274	29083	MAN4610A	REF		
U27	⊗ IC, C-MOS, HEX D FLIP FLOP	404509	12040	MM74C174N	REF		
U28	⊗ IC, CMOS, TRIPLE 3 INPUT NAND GATE	375147	04713	MC14023CP	1	1	
U29	RES, DUAL, IN LINE PACKAGE	358119	89536	358119	2	1	
U30	RES, DUAL, IN LINE PACKAGE	358119	89536	358119	REF		
U31	⊗ IC, C-MOS, HEX D FLIP FLOP	404509	12040	MM74C174N	REF		
U32	⊗ IC CMOS TRI STATE HEX, NON INVERT BUFFER	407759	12040	MM80C97N	1	1	
U33	RES NETWORK	386961	89536	386961	1	1	
XF1	FUSEHOLDER (NOT SHOWN)	435628	89536	435628	1		
XU1	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	13		

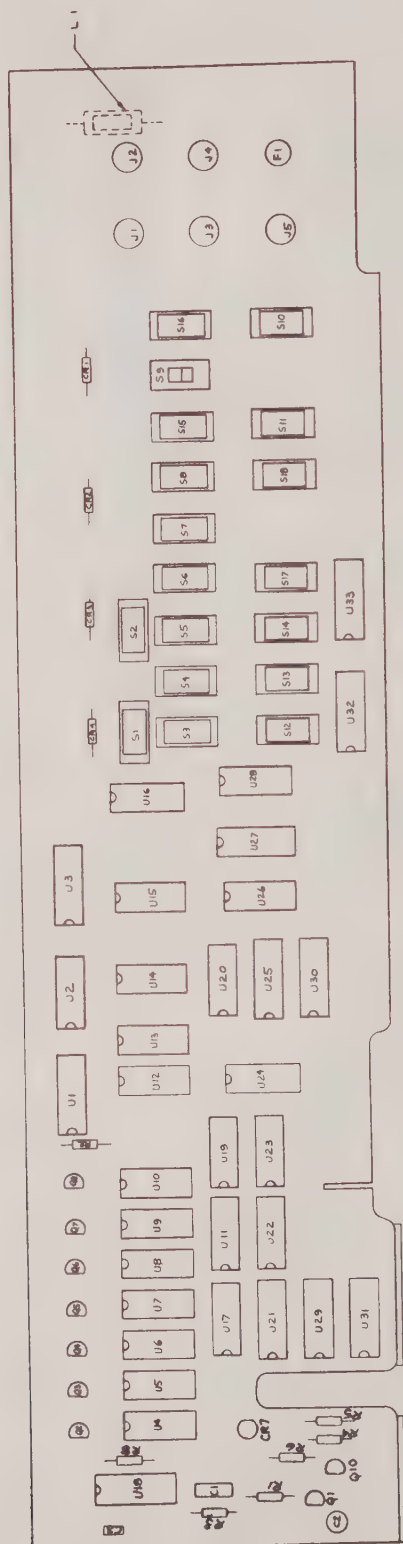


Figure 5-6. A7 Display PCB Assembly

Table 5-8. A8 DC Signal Conditioner Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8	⊗DC SIGNAL CONDITIONER ASSY (MIS-4100T) FIGURE 5-7	383901	89536	383901	REF		
C1	CAP. TA. 5.6UF +/-20%, 25V	368969	56289	196D565X0025KA1	2		
C2	CAP. TA. 5.6UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C3	CAP. CER. 0.22UF +/-20%, 50V	309849	71590	CW30C224K	2		
C4	CAP. CER. 0.22UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C5	CAP. TA. 39UF +/-20%, 6V	163915	56289	196D396X0006	1		
C10	CAP. ELECT. 6.8UF -10/+50%, 63V	218966	80031	ET6P8X063A3	2	1	
C11	CAP. ELECT. 6.8UF -10/+50%, 63V	218966	80031	ET6P8X063A3	REF		
C12	CAP. MICA. 100PF +/-5%, 500V	148494	72136	DM15F101J	2		
C13	CAP. CER. 0.01UF +/-20%, 100V	149153	56289	C023B101F103M	1		
C14	CAP. MICA. 100PF +/-5%, 500V	148494	72136	DM15F101J	REF		
C15	CAP. MICA. 47PF +/-5%, 500V	148536	72316	DM15E470J	2		
C16	CAP. MICA. 47PF +/-5%, 500V	148536	72316	DM15E470J	REF		
C18	CAP. CER. 33PF +/-2%, 100V	354852	80031	2222-638-10339	2		
C19	CAP. CER. 33PF +/-2%, 100V	354852	80031	2222-638-10339	REF		
CR1	DIODE. HI-SPEED SWITCHING	203323	07910	1N4448	2	1	
CR2	DIODE. HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE. ZENER	181073	07910	1N969B	2	1	
CR4	DIODE. ZENER	181073	07910	1N969B	REF		
H1	SPACER. TRANSIPAD (NOT SHOWN. USE W Q37)	152207	07047	10123-DAP	1		
H2	SPACER (NOT SHOWN)	334797	32559	T0-35-15	1		
K1	RELAY. ARMATURE. LO-PROFILE	441261	77342	R40-E0186-1	2		
K2	RELAY. ARMATURE. LO-PROFILE	441261	77342	R40-E0186-1	REF		
MP1	CASE HALF	402990	89536	402990	2		
MP2	COVER	402974	89536	402974	1		
MP3	DECAL	413377	89536	413377	1		
MP4	GUARD. FRONT	383356	89536	383356	1		
MP5	GUARD. REAR	383364	89536	383364	1		
MP6	SHIELD. COVER	411918	89536	411918	1		
MP7	SOCKET. SPRING TYPE (NOT SHOWN)	343285	00779	2-331272-6	8		
MP8	TERMINAL. FEED-THROUGH (NOT SHOWN)	281865	12615	SL-841-777	1		
Q1	TRANSISTOR. NPN. SI	330803	07263	MP56550	2	1	
Q2	TRANSISTOR. PNP. SI	195974	04713	2N3906	6	2	
Q3	TRANSISTOR. NPN. SI	330803	07263	MP56550	REF		
Q4	TRANSISTOR. PNP. SI	195974	04713	2N3906	REF		
Q5	TRANSISTOR. PNP. SI	226290	04713	MP53640	1	1	
Q6	TRANSISTOR. PNP. SI	195974	04713	2N3906	REF		
Q7	TRANSISTOR. NPN. SI	218396	04713	2N3904	11	3	
Q8	TRANSISTOR. FET.. N-CHANNEL	393314	89536	393314	4	1	
Q10	TRANSISTOR. NPN. SI	218396	04713	2N3904	REF		
Q11	TRANSISTOR. NPN. SI	218396	04713	2N3904	REF		
Q12	TRANSISTOR. NPN. SI	218396	04713	2N3904	REF		
Q13	TRANSISTOR. NPN. SI	218396	04713	2N3904	REF		
Q14	TRANSISTOR. FET.. N-CHANNEL	393314	89536	393314	REF		
Q15	TRANSISTOR. FET.. N-CHANNEL	393314	89536	393314	REF		
Q16	TRANSISTOR. FET.. N-CHANNEL	393314	89536	393314	REF		
Q18	TRANSISTOR. NPN. SI	284075	32293	1T1099	1	1	
Q19	TRANSISTOR. NPN. SI	295717	24355	AD811-00/17	1	1	
Q22	TRANSISTOR. NPN. SI	218396	04713	2N3904	REF		
Q23	TRANSISTOR. NPN. SI	218396	04713	2N3904	REF		
Q31	TRANSISTOR. PNP. SI	195974	04713	2N3906	REF		
Q32	TRANSISTOR. NPN. SI	218396	04713	2N3904	REF		
Q33	TRANSISTOR. PNP. SI	195974	04713	2N3906	REF		
Q34	TRANSISTOR. NPN. SI	218396	04713	2N3904	REF		
Q35	TRANSISTOR. PNP. SI	195974	04713	2N3906	REF		
Q36	TRANSISTOR. NPN. SI	218396	04713	2N3904	REF		
Q37	TRANSISTOR. PNP. SI	218388	07263	2N3645	1	1	
Q38	TRANSISTOR. NPN. SI	218396	04713	2N3904	REF		
R1	RES. COMP. 330 +/-5%. 1/4W	147967	01121	CB3315	1		
R2	RES. MF. 28.0K +/-1%. 1/8W	291385	91637	MFF1-82802F	2		
R3	RES. MF. 28.0K +/-1%. 1/8W	291385	91637	MFF1-82802F	REF		
R4	RES. MF. 21K +/-1%. 1/8W	441212	91637	MFF1-82102F	2		
R5	RES. MF. 17.0K +/-1%. 1/8W	349183	91637	MFF1-81782F	2		
R6	RES. CAR. DEP. 470 +/-5%. 1/4W	343434	80031	CR251-45P471T	1		
R7	RES. CAR. DEP. 10K +/-5% 1/4W	348839	80031	CR251-45P103T	5		
R8	RES. COMP. 150K +/-5%. 2W	110122	01121	HB1545	1		
R9	RES. COMP. 150K +/-10%. 1/2W	108167	01121	EB15415	1		
R10	RES. COMP. 150K +/-5%. 1/4W	147934	01121	CB1515	1		

Table 5-8. A8 DC Signal Conditioner Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R12	RES. COMP, 15 +/-5%, 1/4W	147876	01121	CB1505	2		
R13	RES. COMP, 15 +/-5%, 1/4W	147876	01121	CB1505	REF		
R15	RES. CAR. DEP., 1M +/-5%, 1/4W	348987	80031	CR251-45P105T	4		
R16	RES. COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	8		
R17	RES. COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R18	RES. MF, 21K +/-1%, 1/8W	441212	91637	MFF1-82102F	REF		
R19	RES. MF, 17.8K +/-1%, 1/8W	349183	91637	MFF1-81782F	REF		
R21	RES. DIVIDER SET	434605	89536	434605	1	1	
R22	RES. DIVIDER SET	434605	89536	434605	REF		
R23	RES. DIVIDER SET	434605	89536	434605	REF		
R24	RES. DC RANGE SET.	409938	89536	409938	1	1	
R25	RES. DC RANGE SET.	409938	89536	409938	REF		
R26	RES. DC RANGE SET.	409938	89536	409938	REF		
R30	RES. CAR. DEP, 15K +/-5%, 1/4W	348854	80031	CR251-45P153T	1		
R31	RES. CAR. DEP, 10K +/-5% 1/4W	348839	80031	CR251-45P103T	REF		
R32	RES. CAR. DEP, 10K +/-5% 1/4W	348839	80031	CR251-45P103T	REF		
R33	RES. CAR. DEP, 10K +/-5% 1/4W	348839	80031	CR251-45P103T	REF		
R34	RES. CAR. DEP, 10K +/-5% 1/4W	348839	80031	CR251-45P103T	REF		
R35	RES. MF, 1M +/-1%, 1/8W	268797	91637	MFF1-81004F	2		
R36	RES. CERMET, 100M +/-10%, 1W	441758	89536	441758	1		
R47	RES. VAR, 200 +/-20%, 1/2W	284711	71450	190PC201B	1	1	
R48	RES. VAR, CERMET, 50 +/-20%, 1/2W	267815	71450	190PC500B	2	1	
R49	RES. VAR, CERMET, 50 +/-20%, 1/2W	267815	71450	190PC500B	REF		
R50	RES. CAR. DEP, 2.2 +/-5%, 1/4W	354944	80031	CR251-45P2E2T	1		
R51	RES. CAR. DEP, 20 +/-5%, 1/4W	442202	80031	CR251-45P20ET	1		
R52	RES. VAR, CERMET, 100K +/-20%, 1/2W	268581	71450	190PC104B	1	1	
R53	RES. VAR, CERMET, 10K +/-20%, 1/2W	267880	71450	190PC103B	1	1	
R54	RES. SELECTED, DURING TEST				4	1	
R55	RES. SELECTED, DURING TEST				REF		
R56	RES. SELECTED, DURING TEST				REF		
R57	RES. SELECTED, DURING TEST				REF		
R58	RES. SET, MATCHED	290320	89536	290320	1	1	
R59	RES. SET, MATCHED	290320	89536	290320	REF		
R61	RES. MF, 86.6K +/-1%, 1/8W	291468	91637	MFF1-88662F	1		
R62	RES. MF, 1M +/-1%, 1/8W	268797	91637	MFF1-81004F	REF		
R63	RES. MF, 1.87K +/-1%, 1/8W	267229	91637	MFF1-81871F	1		
R64	RES. MF, 1K +/-1%, 1/8W	168229	91637	MFF1-81002F	1		
R70	RES. MF, 52.3K +/-1%, 1/8W	237248	91637	MFF1-85232	1		
R71	RES. MF, 3.01K +/-1%, 1/8W	312645	91637	MFF1-83011F	1		
R72	RES. MF, 3.65K +/-1%, 1/8W	293779	91637	MFF1-83651F	2		
R73	RES. MF, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	2		
R74	RES. MF, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	REF		
R75	RES. MF, 80.6K +/-1%, 1/8W	281121	91637	MFF1-88062F	2		
R76	RES. MF, 4.02 +/-1%, 1/8W	235235	91637	MFF1-84021F	1		
R77	RES. MF, 200K +/-1%, 1/8W	261701	91637	MFF1-82003F	1		
R87	RES. COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R88	RES. COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R89	RES. COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R90	RES. COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R91	RES. COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R92	RES. COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R93	RES. CAR. DEP., 1M +/-5%, 1/4W	348987	80031	CR251-45P105T	REF		
R94	RES. CAR. DEP., 1M +/-5%, 1/4W	348987	80031	CR251-45P105T	REF		
R95	RES. CAR. DEP., 1M +/-5%, 1/4W	348987	80031	CR251-45P105T	REF		
R97	RES. MF, 3.65K +/-1%, 1/8W	293779	91637	MFF1-83651F	REF		
R98	RES. MF, 2.15K +/-1%, 1/8W	293712	91637	MFF1-82151F	1		
R99	RES. MF, 80.6K +/-1%, 1/8W	281121	91637	MFF1-88062F	REF		
U1	⊗ IC DGTL, COS/MOS, QUAD CLOCKED D LATCH	355149	02735	CD4042AE	1	1	
U2	⊗ IC DGTL, C-MOS, TRIPLE 3 INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U3	IC, OP AMP, J-FET, INPUT	310037	12040	LH0042CH	2	1	
U4	IC, OP AMP, J-FET, INPUT	310037	12040	LH0042CH	REF		
U5	IC, OP AMP	271502	12040	LM301A	2	1	
U6	IC, OP AMP	271502	12040	LM301A	REF		

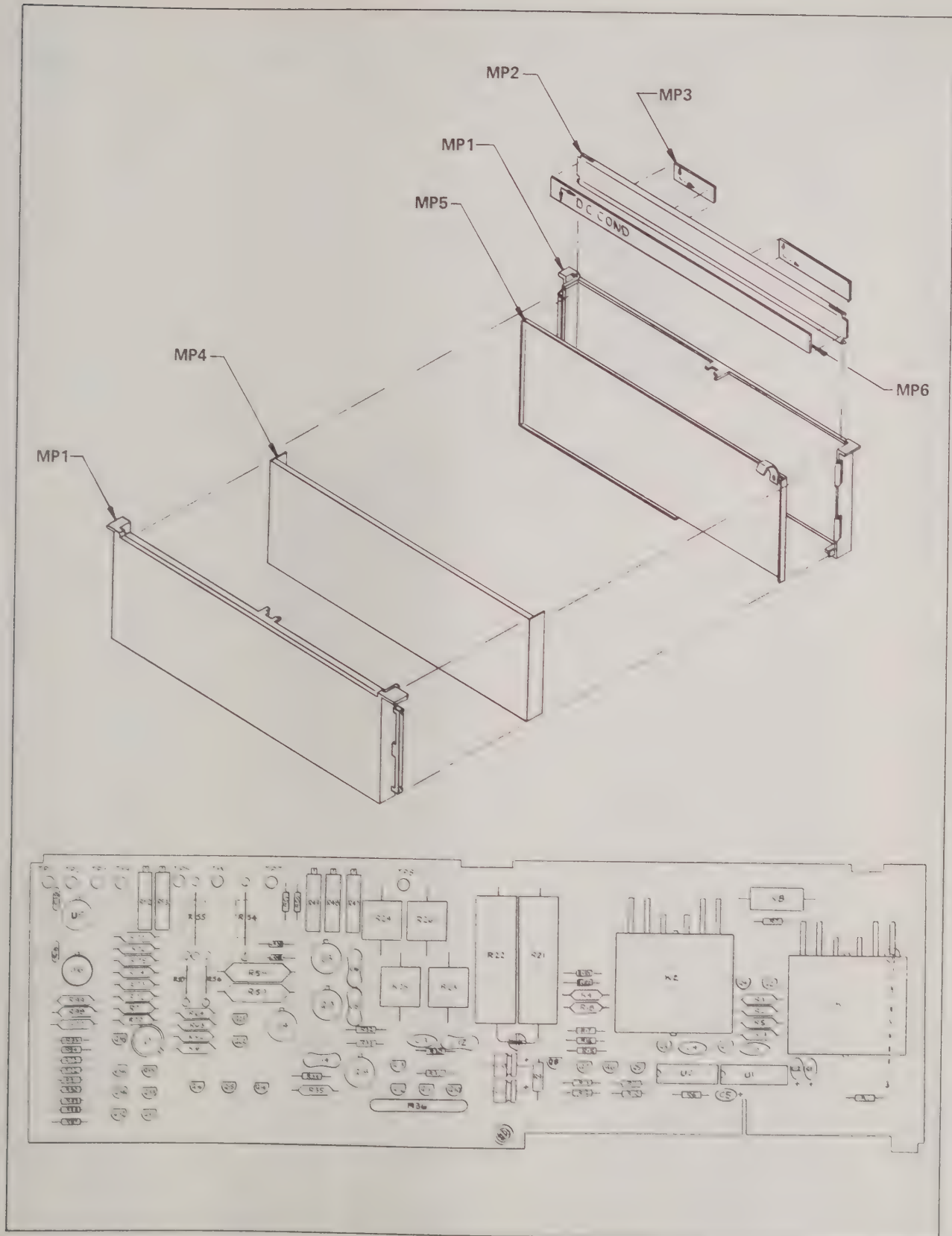


Figure 5-7. A8 DC Signal Conditioner Assembly

Table 5-9. A9 Active Filter Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A9	⊗ ACTIVE FILTER ASSY (MIS 4130T) FIGURE:5-8	383976	89536	383976	1		
C1	CAP. POLYPROP. 0.047UF +/-10%, 50V	413328	89536	413328	3		
C2	CAP. POLYPROP. 0.047UF +/-10%, 50V	413328	89536	413328	REF		
C3	CAP. POLYPROP. 0.047UF +/-10%, 50V	413328	89536	413328	REF		
C4	CAP. MICA, 33PF +/-5%, 500V	160317	72136	DM15E330J	4		
C5	CAP. POLYPROP. 0.47UF +/-10%, 50V	363085	89536	363085	3		
C6	CAP. POLYPROP. 0.47UF +/-10%, 50V	363085	89536	363085	REF		
C7	CAP. POLYPROP. 0.47UF +/-10%, 50V	363085	89536	363085	REF		
C8	CAP. MICA, 33PF +/-5%, 500V	160317	72136	DM15E330J	REF		
C9	CAP. MICA, 33PF +/-5%, 500V	160317	72136	DM15E330J	REF		
C10	CAP. MICA, 33PF +/-5%, 500V	160317	72136	DM15E330J	REF		
C11	CAP. ELECT. 6.8UF -10/+50%, 6.3V	218966	73445	ET6P8X063A3	2	1	
C12	CAP. ELECT. 10UF -10/+50%, 25V	170266	73445	ET100X25A2	2	1	
C13	CAP. ELECT. 10UF -10/+50%, 25V	170266	73445	ET100X25A2	REF		
C14	CAP. ELECT. 6.8UF -10/+50%, 6.3V	218966	73445	ET6P8X063A3	REF		
C15	CAP. POLYPROP. 0.0022 +/-10%, 200V	442632	89536	442632	1	1	
CR1	DIODE, ZENER	260695	07910	1N754A	1	1	
CR2	DIODE, ZENER	386557	07910	1N960A	1	1	
CR3	DIODE, ZENER	203323	07910	1N4448	1	1	
H1	SPACER (USE W Q26 - NOT SHOWN)	152207	07047	10123DAP	1		
MP1	CASE HALF	402990	89536	402990	2		
MP2	COVER	402974	89536	402974	1		
MP3	DECAL	413443	89536	413443	1		
MP4	GUARD, FRONT	383356	89536	383356	1		
MP5	GUARD, REAR	383364	89536	383364	1		
MP6	SHIELD, COVER	411959	89536	411959	1		
Q1	TRANSISTOR, SI, PNP	195974	04713	2N3906	6	2	
Q2	TRANSISTOR, SI, NPN	218396	04713	2N3904	9	2	
Q3	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q4	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q5	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q6	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q7	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q8	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q9	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q10	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q11	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q12	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q13	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1	1	
Q14	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	14	3	
Q15	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q16	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q17	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q18	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q19	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q20	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q21	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q22	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q23	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q24	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q25	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q26	TRANSISTOR, SI, PNP	218388	07263	2N3645	1	1	
Q27	TRANSISTOR, SI, NPN	284075	32293	1TS1099	1	1	
Q28	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q29	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q30	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q31	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q32	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
R1	RES. CAR. DEP. 6.2K +/-5%, 1/4W	442368	80031	CR251-45P622T	1		
R2	RES. COMP. 150 +/-5%, 1/4W	147934	01121	CB1515	1		
R3	RES. MF, 51.1K +/-5%, 1/8W	289553	91637	MFF1-85112F	1		
R4	RES. COMP. 8.2K +/-5%, 1/4W	160796	01121	CB8225	2		
R5	RES. COMP. 8.2K +/-5%, 1/4W	160796	01121	CB8225	REF		
R8	RES. MF, 45.3K +/-1%, 1/8W	234971	91637	MFF1-84532F	4		
R9	RES. MF, 45.3K +/-1%, 1/8W	234971	91637	MFF1-84532F	REF		
R10	RES. MF, 45.3K +/-1%, 1/8W	234971	91637	MFF1-84532F	REF		
R11	RES. MF, 45.3K +/-1%, 1/8W	234971	91637	MFF1-84532F	REF		
R12	RES. MF, 12.1K +/-1%, 1/8W	234997	91637	MFF1-81212F	3		

Table 5-9. A9 Active Filter Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R13	RES. MF, 4.8K +/-1%, 1/8W	294850	91637	MFF1-84871F	1		
R14	RES. VAR. CERMET. 20K +/-10%, 1/2W	291609	89536	291609	1	1	
R15	RES. SELECTED, DURING TEST						
R16	RES. SELECTED, DURING TEST						
R17	RES. MF, 1M +/-1%, 1/2W	327510	91637	MFF1-21004F	2		
R18	RES. MF, 1M +/-1%, 1/2W	327510	91637	MFF1-21004F			
R19	RES. MF, 12.1K +/-1%, 1/8W	234997	91637	MFF1-81212F	REF		
R20	RES. MF, 249K +/-1%, 1/8W	268805	91637	MFF1-82493F	2		
R21	RES. MF, 57.6K +/-1%, 1/8W	289116	91637	MFF1-85762F	1		
R22	RES. MF, 12.1K +/-1%, 1/8W	234997	91637	MFF1-81212F	REF		
R23	RES. MF, 249K +/-1%, 1/8W	268805	91637	MFF1-82493F	REF		
R24	RES. COMP, 15 +/-5%, 1/4W	147876	01121	CB1505	2		
R25	RES. COMP, 100 +/-5%, 1/4W	147926	01121	CB1015	2		
R26	RES. COMP, 100 +/-5%, 1/4W	147926	01121	CB1015	REF		
R27	RES. COMP, 15 +/-5%, 1/4W	147876	01121	CB1505	REF		
R28	RES. MF, 26.7K +/-1%, 1/8W	245779	91637	MFF1-82672F	2		
R29	RES. MF, 26.7K +/-1%, 1/8W	245779	91637	MFF1-82672F	REF		
U1	⊗ IC, DCTL, C-MOS, HEX D FF	404509	12040	MM74C174N	1	1	
U2	⊗ IC, DCTL CMOS, TRIPLE 3 INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U3	IC, LINEAR, OP AMP	363515	12040	LM301AN	2	1	
U4	IC, LINEAR, OP AMP	363515	12040	LM301AN	REF		
U5	IC, LINEAR, OP AMP	392902	12040	LM1346H	1	1	
U6	RESISTOR NETWORK, 100K +/-10%, 1/4W	404749	89536	404749	1	1	
U7	RESISTOR NETWORK, 100K +/-10%, 10V	380618	89536	380618	1	1	
XR1	SOCKET (USE WITH R15, R16). NOT SHOWN	343285	00779	2-331272-6	4		

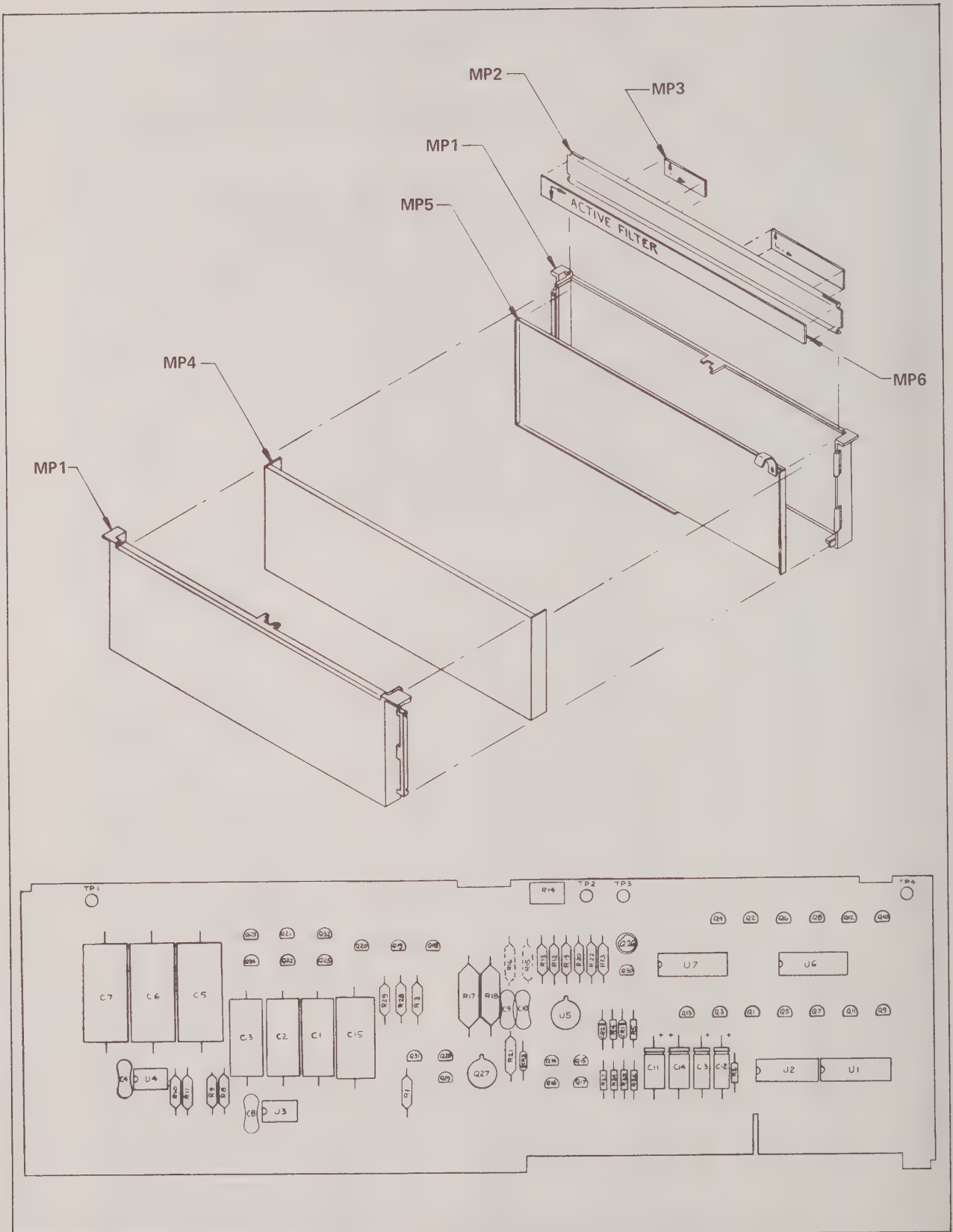


Figure 5-8. A9 Active Filter Assembly

Table 5-10. A10 Fast RR A/D Converter Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10	⊗ FAST RR A/D CONVERTER ASSY (MIS 4140T) FIGURE: 5-9	383984	89536	383984	1		
A10A1	A/D ANALOG ASSEMBLY (MIS-4140)	383752	89536	383752	1		
A10A2	⊗ A/D DIGITAL ASSEMBLY (MIS-4141)	383760	89536	383760	1		
H1	SPACER	152207	07047	10123DAP	1		
MP1	CASE HALF	402990	89536	402990	1		
MP2	CASE HALF	402982	89536	402982	1		
MP3	COVER	402974	89536	402974	1		
MP4	DECAL	413450	89536	413450	1		
MP5	GUARD, FRONT	383315	89536	383315	1		
MP6	GUARD, REAR	383364	89536	383364	1		
MP7	SHIELD, COVER	411967	89536	411967	1		

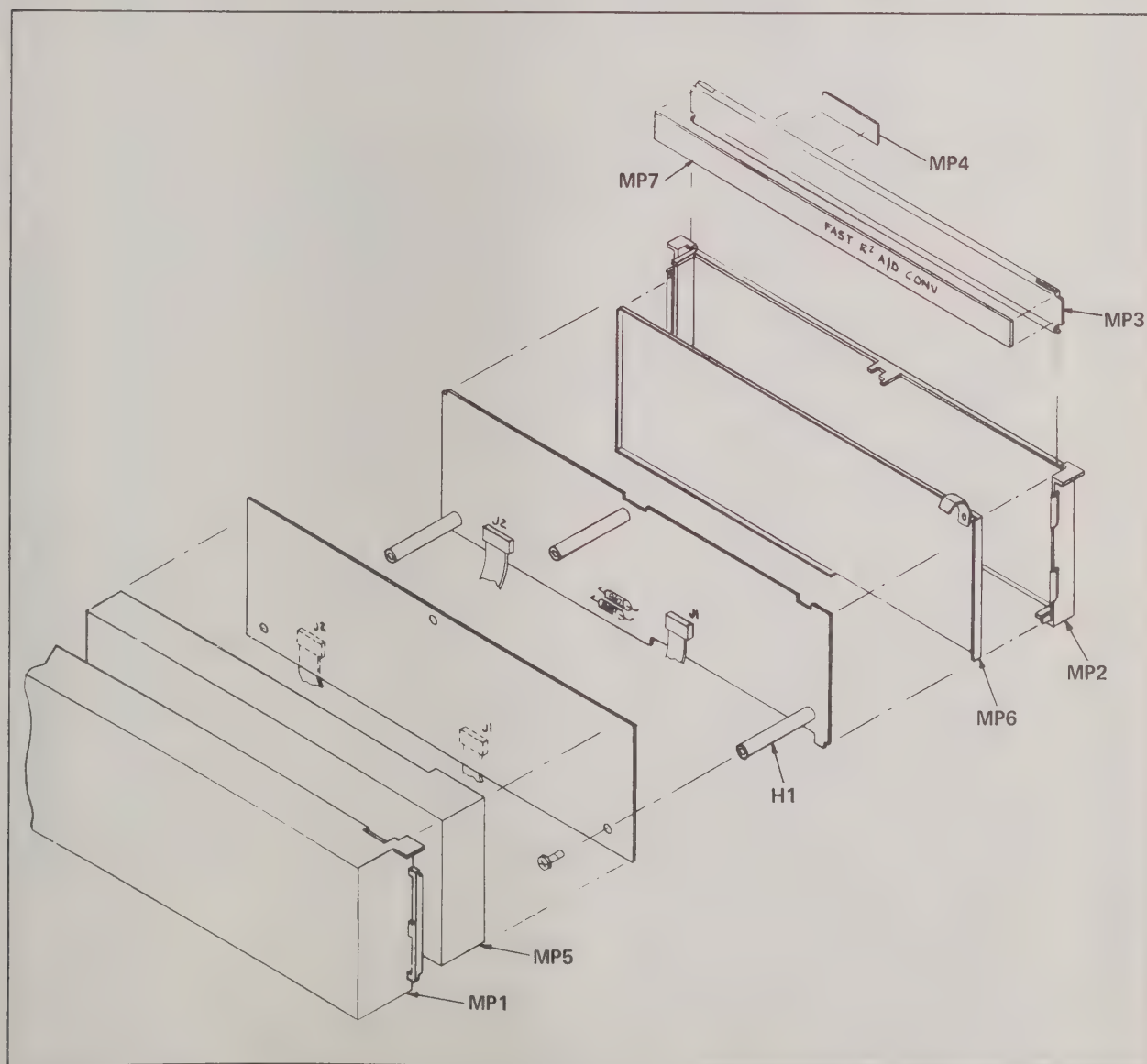


Figure 5-9. A10 Fast RR A/D Converter Assembly

Table 5-11. A10A1 A/D Analog PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10A1	A/D ANALOG ASSEMBLY (MIS-4140) FIGURE: 5-10	383752	89536	383752	1		
C1	CAP. TA, 10UF +/-20%, 35V	417683	56289	196D106X0035KA1	2		
C2	CAP. TA, 10UF +/-20%, 35V	417683	56289	196D106X0035KA1	REF		
C3	CAP. MICA, 33PF +/-5%, 500V	160317	72136	DM15E330J	1		
C4	CAP. MICA, 30PF +/-5%, 500V	340570	72136	DM15E300J	1		
C5	CAP. FILM, 0.22UF +/-10%, 80V	159392	56289	192P2249R8	1		
C6	CAP. TA, 4.7UF +/-20%, 25V	161943	56289	196D475X0025KA1	1		
C7	CAP. MICA, 150PF +/-5%, 500V	148478	72136	DM15F151J	2		
C8	CAP. MICA, 150PF +/-5%, 500V	148478	72136	DM15F151J	REF		
C9	CAP. POLYST, 0.047UF +/-10%, 100V	260562	84411	863UU47391	2		
C10	CAP. POLYST, 0.047UF +/-10%, 100V	260562	84411	863UU47391	REF		
C11	CAP. MICA, 47PF +/-5%, 500V	148536	72136	DM15E470J	3		
C12	CAP. MICA, 47PF +/-5%, 500V	148536	72136	DM15E470J	REF		
C13	CAP. ELECT, 470UF -10/+50%, 6.3V	187773	80031	ET471X6P3A6	1	1	
C14	CAP. MICA, 47PF +/-5%, 500V	148536	72136	DM15E470J	REF		
C15	CAP. CER. 0.0047UF +/-10%, 500V	106724	71590	CF-472	1		
C16	CAP. CER. 0.22UF +/-20%, 50V	309849	71590	CW30C224K	2		
C17	CAP. CER. 0.22UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C18	CAP. TA, 68UF +/-20%, 25V	446450	56289	196D686X0025TE4	1		
C20	CAP. TA, 0.22UF +/-20%, 35V	161331	56289	196D224X0035HA1	1		
C21	CAP. MICA, 1000PF +/-5%, 500V	148353	72136	DM19F182J	1		
CR1	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	2	1	
CR3	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223	4	1	
CR4	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR5	DIODE, SI, CONTROLLER FWD VOL	234468	07910	TD9039	2	1	
CR6	DIODE, SI, CONTROLLER FWD VOL	234468	07910	TD9039	REF		
CR7	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR8	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR9	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4443	REF		
J1	SOCKET	276535	91506	316-AG39D	2		
J2	SOCKET	276535	91506	316-AG39D	REF		
Q1	TRANSISTOR, FET (SELECTED)	256487	89536	256487	1	1	
Q2	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q3	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q4	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	5	1	
Q5	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q6	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q7	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q8	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q9	TRANSISTOR, FET, DUAL, N-CHANNEL	376087	89536	376087	2	1	
Q10	TRANSISTOR, SI, NPN	218396	04713	2N3904	1	1	
Q11	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q12	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q13	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q14	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q15	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q16	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q17	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	12	3	
Q18	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q19	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q20	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q21	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q22	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q23	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q24	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q25	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q26	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q27	TRANSISTOR, FET, DUAL, N-CHANNEL	376087	89536	376087	REF		
Q28	TRANSISTOR, SI, PNP	195974	04713	2N3906	1	1	
Q29	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q30	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q31	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q32	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
P1	RES. VAR, CERMET, 500 +/-20%, 1/2W	267849	75379	190PC501B	1	1	
R2	RES. VAR, CERMET, 10 +/-20%, 1/2W	344135	75378	190PC100B	2	1	
R3	RES. VAR, CERMET, 500 +/-10%, 1/2W	291120	89536	291120	1	1	
R4	RES. VAR, CERMET, 200 +/-10%, 1/2W	285148	89536	285148	1	1	
R5	RES. VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285122	2	1	

Table 5-11. A10A1 A/D Analog PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R6	RES. VAR. CERMET, 20 +/-20%, 1/2W	261180	75378	190PC200B	1	1	
R7	RES. VAR. CERMET, 50 +/-10%, 1/2W	285122	89536	285122	REF		
R8	RES. VAR. CERMET, 50K +/-10%, 1/2W	288290	89536	288290	1	1	
R9	REF. AMP SET (U1,R9,R14,R15,R16)	415034	89536	415034	REF		
R10	RES. MF, 3.4K +/-1%, 1/8W	260323	91637	MFF1-83401F	1		
R11	RES. MF, 12.1 +/-1%, 1/8W	296608	91637	MFF1-812R1F	2		
R12	RES. MF, 24.3 +/-1%, 1/8W	208186	91637	MFF1-824R3F	1		
R13	RES. MF, 12.1 +/-1%, 1/8W	296608	91637	MFF1-812R1F	REF		
R14	REF. AMP SET (U1,R9,R14,R15,R16)	415034	89536	415034	REF		
R15	REF. AMP SET (U1,R9,R14,R15,R16)	415034	89536	415034	REF		
R16	REF. AMP SET (U1,R9,R14,R15,R16)	415034	89536	415034	REF		
R17	RES. MF, 10K +/-1%, 1/8W(T9)	328120	91637	MFF1-81002F	2		
R18	RES. MF, 10K +/-1%, 1/8W(T9)	328120	91637	MFF1-81002F	REF		
R19	RES. COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	3		
R20	RES. MF, 10K +/-1%, 1/8W (T0)	168260	91637	MFF1-81002F	3		
R21	RES. COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R22	RES SET (R22, R23)	409896	89536	409896	1		
R23	RES SET (R22, R23)	409896	89536	409896	1		
R24	RES. COMP, 470 +/-5%, 1/4W	147983	01121	CB4715	1		
R25	RES. MF, 49.9K +/-1%, 1/8W	268821	91637	MFF1-84992F	2		
R26	RES. MF, 49.9K +/-1%, 1/8W	268821	91637	MFF1-84992F	REF		
R27	RES. COMP, 62 +/-5%, 1/4W	261842	01121	CB6205	1		
R28	RES. MF, 10K +/-1%, 1/8W (T0)	168260	91637	MFF1-81002F	3		
R29	RES. COMP, 33K +/-5%, 1/4W	148155	01121	CB3335	2		
R30	RES. MF, 10K +/-1%, 1/8W (T0)	168260	91637	MFF1-81002F	REF		
R31	RES. MF, 11.3K +/-1%, 1/8W	293639	91637	MFF1-81132F	1		
R32	RES. MF, 24.9K +/-1%, 1/8W	291369	91637	MFF1-82492F	1		
R33	RES. COMP, 47 +/-5%, 1/4W	147892	01121	CB4705	2		
R34	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	1	1	
R35	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R36	RES. MF, 26.7K +/-1%, 1/8W	245779	91637	MFF1-82672F	1		
R37	RES. COMP, 47 +/-5%, 1/4W	147892	01121	CB4705	REF		
R38	RES. MF, 75K +/-1%, 1/8W	291443	91637	MFF1-87502F	3		
R39	RES. MF, 75K +/-1%, 1/8W	291443	91637	MFF1-87502F	REF		
R40	RES. COMP, 15K +/-5%, 1/4W	148114	01121	CB1535	2		
R41	RES. MF, 75K +/-1%, 1/8W	291443	91637	MFF1-87502F	REF		
R42	RES. COMP, 3K +/-5%, 1/4W	193508	01121	CB3025	1		
R43	RES. COMP, 510 +/-5%, 1/4W	218032	01121	CB5115	1		
R44	RES. COMP, 1.5K +/-5%, 1/4W	148031	01121	CB1525	1		
R45	RES. COMP, 470K +/-5%, 1/4W	188441	01121	CB4745	1		
R46	RES. MF, 665 +/-1%, 1/8W	320028	91637	MFF1-86650F	1		
R47	RES. MF, 1M +/-1%, 1/8W	268797	91637	MFF1-81004F	1		
R48	RES. COMP, 15K +/-5%, 1/4W	148114	01121	CB1535	REF		
R49	RES. COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	REF		
R50	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R51	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R52	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R53	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R54	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R55	RES. MF, 56.2 +/-1%, 1/8W	305938	91637	MFF1-856R2F	1		
R56	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R58	RES. MF, 2573 +/-0.1%, 1/8W	321463	91637	MFF1-82573F	1		
R60	RES. COMP, 33K +/-5%, 1/4W	148155	01121	CB3335	REF		
R61	RES. MF, 57.6K +/-1%, 1/8W	289116	91637	MFF1-85762F	1		
R62	RES. MF, 66.5K +/-1%, 1/8W	289082	91637	MFF1-86652F	1		
R63	RES. MF, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	1		
R64	RES. VAR. CERMET, 10 +/-20%, 1/2W	344135	75378	190PC100B	REF		
R65	RES. COMP, 820 +/-5%, 1/4W	148015	01121	CB8215	1		
R66	RES. COMP, 5.1K +/-5%, 1/4W	193342	01121	CB5125	1		
R67	RES. MF, 18.7 +/-1%, 1/8W	441776	91637	MFF1-812R7F	1		
R68	RES. COMP, 1M +/-5%, 1/4W	182204	01121	CB1055	1		

Table 5-11. A10A1 A/D Analog PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U1	REF. AMP SET (U1,R9,R14,R15,R16)	415034	89536	415034	1	1	
U1	REF AMP SET	415034	89536	415034	1	1	
U2	IC OP AMP	271502	12040	LM301A	2	1	
U3	IC OP AMP	271502	12040	LM301A	REF		
U4	IC OP AMP, J-FET, INPUT	310037	12040	LH0042CH	2	1	
U5	IC, LIN. VOL, FOLLOWER	288365	12040	LM310H	2	1	
U6	IC, LIN. VOL, FOLLOWER	288365	12040	LM310H	REF		
U7	IC OP AMP, J-FET, INPUT	310037	12040	LH0042CH	REF		
U8	IC, OP AMP	225961	24355	AD3092	1	1	
U15	RES NETWORK, 33K	413146	89536	413146	1	1	
U19	RES NETWORK, 100K	380618	89536	380618	1	1	

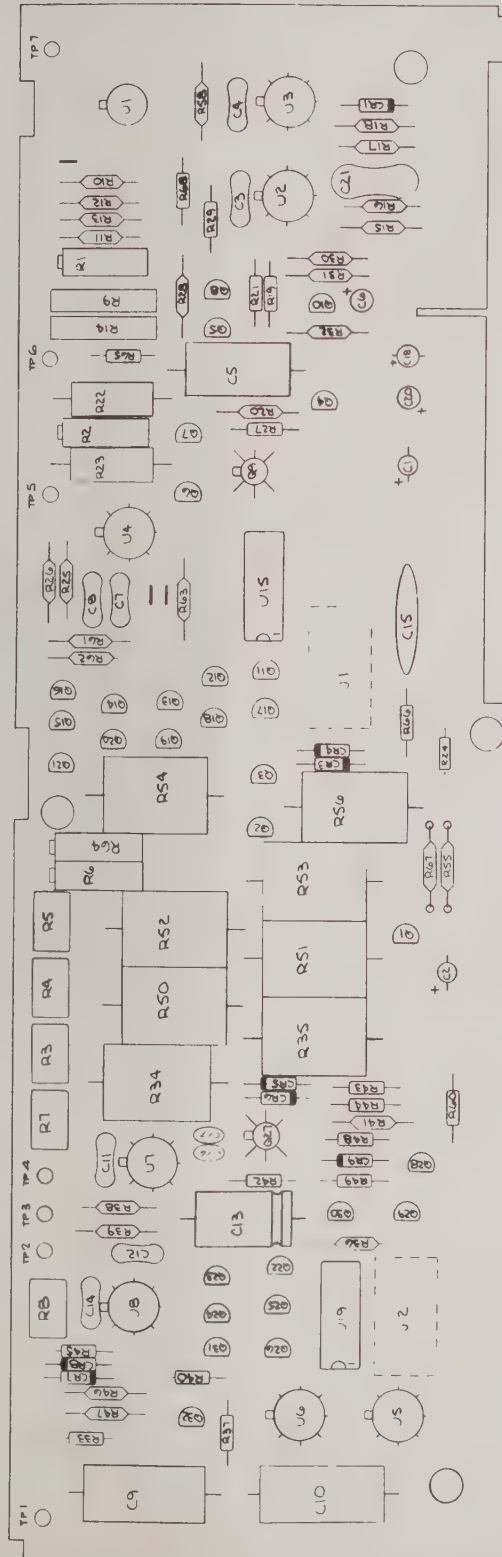


Figure 5-10. A10A1 A/D Analog PCB Assembly

Table 5-12. A10A2 Fast RR A/D Converter Digital PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10A2	⊗ FAST RR A/D CONV DGTL ASSY (MIS 1741) FIGURE: 5-11	383760	89536	383760	1		
C1	CAP, TA, 220UF +/-20%, 6V	408682	56289	196D227X0006TE4	2		
C2	CAP, MICA, 82PF +/-5%, 500V	148502	72136	DM15F820J	2		
C3	CAP, MICA, 82PF +/-5%, 500V	148502	72136	DM15F820J	REF		
J1	CABLE ASSY, 16 PIN CONN	380576	08261	5122-003.5	2		
J2	CABLE ASSY, 16 PIN CONN	380576	08261	5122-003.5	REF		
Q1	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1		
R1	RES, COMP, 47K +/-5%, 1/4W	148163	01121	CB4735	1		
R2	RES, COMP, 20K +/-5%, 1/4W	221614	01121	CB2035	2		
R3	RES, COMP, 20K +/-5%, 1/4W	221614	01121	CB2035	REF		
R4	RES, COMP, 150 +/-5%, 1/4W	147934	01121	CB1515	1		
R5	RES, MF, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	2		
R6	RES, MF, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	REF		
R7	RES, COMP, 100K +/-5%, 1/4W	148189	01121	CB1045	1		
U1	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	9	2	
U2	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U3	⊗ IC, DGTL, C-MOS, HEX INVERTER	404681	02735	CD4069BE	3	1	
U4	RES NETWORK	380618	89536	380618	3	1	
U5	⊗ IC, DGTL, C-MOS, DUAL, COMPLEMENTARY	408013	02735	CD4007AE	1	1	
U6	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U7	⊗ IC, DGTL, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U8	⊗ IC DGTL, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE	2	1	
U11	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U12	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U13	RES NETWORK	380618	89536	380618	REF		
U14	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E	5	1	
U15	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E	REF		
U16	⊗ IC, DGTL, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE	2	1	
U17	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E	REF		
U21	⊗ IC, DGTL, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U22	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U23	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E	REF		
U25	⊗ IC, DGTL, C-MOS, QUAD, 2-INPUT, AND GATE	408401	02735	CD4081BE	1	1	
U26	⊗ IC, DGTL, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE	REF		
U31	⊗ IC, DGTL, C-MOS, DIV BY -8, COUNTER/DIV	403360	02735	CD4022AE	1	1	
U32	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U33	⊗ IC DGTL, C-MOS, QUAD, 2-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U34	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U35	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U36	⊗ IC DGTL, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE	REF		
U37	RES NETWORK	380618	89536	380618	REF		
U38	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E	REF		

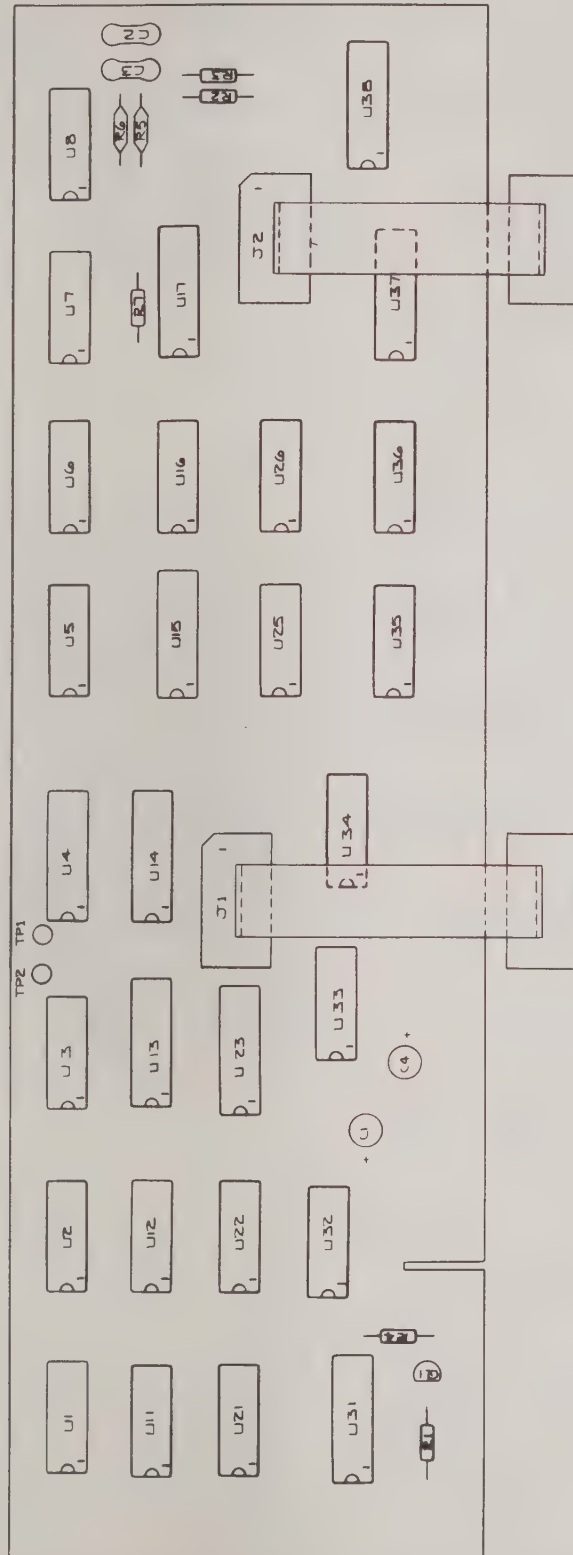


Figure 5-11. A10A2 Fast RR A/D Converter Digital PCB Assembly

Table 5-13. Input Switch Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A11	INPUT SWITCH ASSY (8500A/AE-4414) FIGURE:5-1	472589	89536	472589	1		
E1	SPARK GAP	442731	25088	B2-B470	1		
R1	RESISTOR, MF, 30.9K +/-1%, 1/2W	247569	91637	CMF653092F 2	2		
R2	RESISTOR, MF, 30.9K +/-1%, 1/2W	247569	91637	CMF653092F 2	REF		
R3	RESISTOR, COMP, 300 +/-5%, 1/4W	348276	01121	CB3015	1		
S1	SWITCH, INPUT	473538	89536	473538	1		
W1	CABLE, PCB TO SWITCH	472662	89536	472662	1		

Table 5-14. Rear Input Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A12	REAR INPUT ASSY (8500A/AE-4413) FIGURE:5-1	472571	89536	472571	1		
F1	FUSE, AGC, 1 1/2	109330	71400	AGC 1 1/2	5		
LR1	RESISTOR COIL ASSY	438325	89536	438325	1		
W1	CABLE, INPUT REAR	472555	89536	472555	1		
XF1	FUSE HOLDER	435628	89536	435628	2		

Accessories

600-1. RACK EAR MOUNTING ASSEMBLY

600-2. Figure 600-1 illustrates installation of the Rack Ear Mounting Assembly. Use the following procedure.

1. Remove the nameplate decals from handles.
2. Remove the screws from handles.
3. Attach rack ears with # 8 - 32 x 5/8 PHP screws (enclosed in kit).
4. Remove the front screws from top and bottom cover which match the hole pattern in trim items.
5. Attach trim angle on top cover and trim channel on bottom cover with # 6 - 32 x 3/8 PHP screws and lock washer (enclosed in kit).

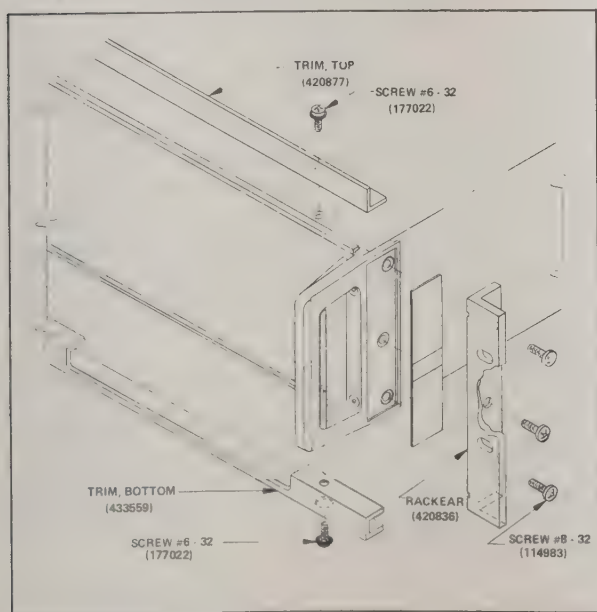


Figure 600-1. Rack Ear Mounting Installation

600-3. HIGH VOLTAGE PROBE (80F-5)

600-4. The Model 80F-5 Voltage Divider shown in Figure 600-2 allows measurement of up to 5k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

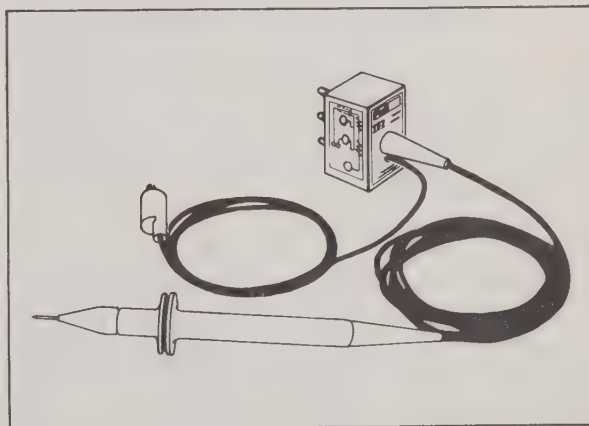


Figure 600-2. 80F5 Voltage Divider

600-5. Physical design of the Model 80F-5 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measurement source. Maintenance is minimized by encapsulation of the divider components.

600-6. Three versions of the Model 80F-5 are available. The basic Model 80F-5 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided

for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohms or greater) at null.

600-7. HIGH VOLTAGE PROBE (80F-15)

600-8. The Accessory Model 80F-15 Voltage Divider, shown in Figure 6-7, allows measurement of up to 15k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

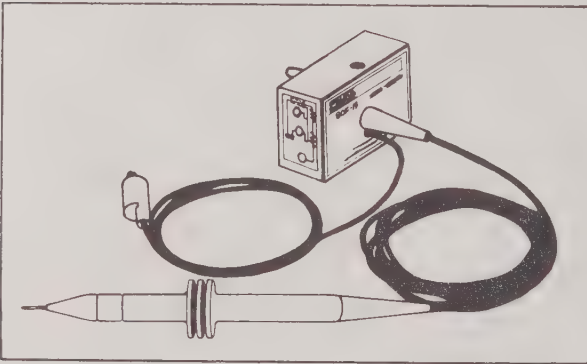


Figure 600-3. 80F15 Voltage Divider

600-9. Physical design of the Model 80F-15 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measurement source. Maintenance is minimized by encapsulation of the divider components.

600-10. Three versions of the Model 80F-15 are available. The basic Model 80F-15 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohm or greater) at null.

600-11. HIGH FREQUENCY PROBE (81 RF)

600-12. The Model 81RF High Frequency Probe, Figure 600-4, extends the frequency range of the DVM/DMM to include 100 kHz to 100 MHz for ac voltage measurements from 0.25 to 30V rms. The 81RF operates in conjunction with the dc voltage ranges, and is connected to the DVM/DMM using a shielded dual-banana plug and, when necessary, a dual banana adaptor.

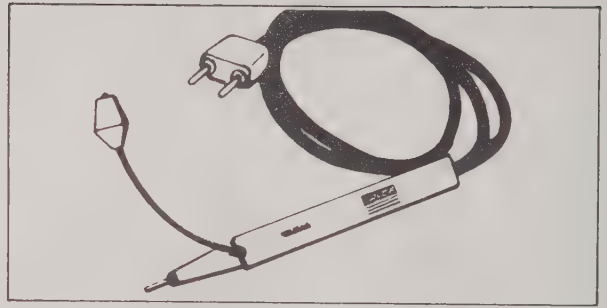


Figure 600-4. 81RF High Frequency Probe

600-13. HIGH FREQUENCY PROBE (82RF)

600-14. The Model 82RF High Frequency Probe, Figure 600-5, allows measurements over a frequency range of 100 kHz to 500 MHz from 0.25 to 30V rms. It is designed to be used with voltmeters having an input impedance of 10 megohms $\pm$ 10%. It may be used with a voltmeter having an input impedance higher than 10 megohms provided the input is externally shunted to make the equivalent input impedance equal to 10 megohms.

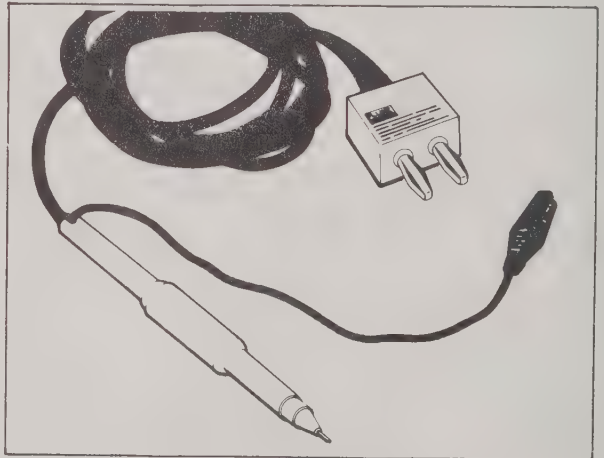


Figure 600-5. 82RF High Frequency Probe

600-15. Circuitry within the 82RF consists of a capacitor-coupled rectifier circuit which responds to the peak value of the input waveform. The output is positive polarity dc which is calibrated to be equivalent to the rms value of a sine wave.

600-16. KEYBOARD DISPLAY MODULE (KDM1)

600-17. The Micon KDM1 Keyboard Display Module is a LED display terminal (with a connecting cable) for use with the Bit Serial Asynchronous Interface (Option -06). Standard ASCII characters are used on the keyboard to facilitate programming the 8500A/AE.

Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

List of Abbreviations and Symbols

A or amp	ampere	hf	high frequency	(+) or pos	positive
ac	alternating current	Hz	hertz	pot	potentiometer
af	audio frequency	IC	integrated circuit	p-p	peak-to-peak
a/d	analog-to-digital	if	intermediate frequency	ppm	parts per million
assy	assembly	in	inch(es)	PROM	programmable read-only memory
AWG	american wire gauge	intl	internal	psi	pound-force per square inch
B	bel	I/O	input/output	RAM	random-access memory
bcd	binary coded decimal	k	kilo (10 ³)	rf	radio frequency
°C	Celsius	kHz	kilohertz	rms	root mean square
cap	capacitor	kΩ	kilohm(s)	ROM	read-only memory
ccw	counterclockwise	kV	kilovolt(s)	s or sec	second (time)
cer	ceramic	lf	low frequency	scope	oscilloscope
cermet	ceramic to metal(seal)	LED	light-emitting diode	SH	shield
ckt	circuit	LSB	least significant bit	Si	silicon
cm	centimeter	LSD	least significant digit	serno	serial number
cmrr	common mode rejection ratio	M	mega (10 ⁶)	sr	shift register
comp	composition	m	milli (10 ⁻³)	Ta	tantalum
cont	continue	mA	milliampere(s)	tb	terminal board
crt	cathode-ray tube	max	maximum	tc	temperature coefficient or temperature compensating
cw	clockwise	mf	metal film	tcxo	temperature compensated crystal oscillator
d/a	digital-to-analog	MHz	megahertz	tp	test point
dac	digital-to-analog converter	min	minimum	u or μ	micro (10 ⁻⁶)
dB	decibel	mm	millimeter	uhf	ultra high frequency
dc	direct current	ms	millisecond	us or μs	microsecond(s) (10 ⁻⁶)
dmm	digital multimeter	msb	most significant bit	uut	unit under test
dvm	digital voltmeter	MSD	most significant digit	V	volt
elect	electrolytic	MTBF	mean time between failures	v	voltage
ext	external	MTTR	mean time to repair	var	variable
F	farad	mV	millivolt(s)	vco	voltage controlled oscillator
°F	Fahrenheit	mv	multivibrator	vhf	very high frequency
FET	Field-effect transistor	MΩ	megohm(s)	vlf	very low frequency
ff	flip-flop	n	nano (10 ⁻⁹)	W	watt(s)
freq	frequency	na	not applicable	ww	wire wound
FSN	federal stock number	NC	normally closed	xfmr	transformer
g	gram	(-) or neg	negative	xstr	transistor
G	giga (10 ⁹)	NO	normally open	xtal	crystal
gd	guard	ns	nanosecond	xtlo	crystal oscillator
Ge	germanium	opnl ampl	operational amplifier	Ω	ohm(s)
GHz	gigahertz	p	pico (10 ⁻¹²)	μ	micro (10 ⁻⁶)
gmV	guaranteed minimum value	para	paragraph		
gnd	ground	pcb	printed circuit board		
H	henry	pF	picofarad		
hd	heavy duty	pn	part number		

Federal Supply Codes for Manufacturers

00213 Nytronics Comp. Group Inc. Subsidiary of Nytronics Inc. Formerly Sage Electronics Rochester, New York	02660 Bunker Ramo Corp., Conn Div. Formerly Amphenol-Borg Electric Corp. Broadview, Illinois	04946 Standard Wire & Cable Los Angeles, California	06751 Components, Inc. Semcor Div. Phoenix, Arizona
00327 Welwyn International, Inc. Westlake, Ohio	02799 Areo Capacitors, Inc. Chatsworth, California	05082 Replaced by 94988	06860 Gould Automotive Div. City of Industry, California
00656 Aerovox Corp. New Bedford, Massachusetts	03508 General Electric Co. Semiconductor Products Syracuse, New York	05236 Jonathan Mfg. Co. Fullerton, California	06961 Vernitron Corp., Piezo Electric Div. Formerly Clevite Corp., Piezo Electric Div. Bedford, Ohio
00686 Film Capacitors, Inc. Passaic, New Jersey	03614 Replaced by 71400	05245 Components Corp. now Corcom, Inc. Chicago, Illinois	06980 Eimac Div. Varian Associates San Carlos, California
00779 AMP Inc. Harrisburg, Pennsylvania	03651 Replaced by 44655	05277 Westinghouse Electric Corp. Semiconductor Div. Youngwood, Pennsylvania	07047 The Ross Milton Co. South Hampton, Pennsylvania
01121 Allen-Bradley Co. Milwaukee, Wisconsin	03797 Eldema Div. Genisco Technology Corp. Compton, California	05278 Replaced by 43543	07115 Replaced by 14674
01281 TRW Electronic Comp. Semiconductor Operations Lawndale, California	03877 Transistron Electronic Corp. Wakefield, Massachusetts	05279 Southwest Machine & Plastic Co. Glendora, California	07138 Westinghouse Electric Corp., Electronic Tube Div. Horsehead, New York
01295 Texas Instruments, Inc. Semiconductor Group Dallas, Texas	03888 KDI Pyrofilm Corp. Whippany, New Jersey	05397 Union Carbide Corp. Materials Systems Div. New York, New York	07233 TRW Electronic Components Cinch Graphic City of Industry, California
01537 Motorola Communications & Electronics Inc. Franklin Park, Illinois	03911 Clairex Electronics Div. Clairex Corp. Mt. Vernon, New York	05571 Use 56289 Sprague Electric Co. Pacific Div. Los Angeles, California	07256 Silicon Transistor Corp. Div. of BBF Group Inc. Chelmsford, Massachusetts
01686 RCL Electronics Inc. Manchester, New Hampshire	03980 Muirhead Inc. Mountainside, New Jersey	05574 Viking Industries Chatsworth, California	07261 Aumet Corp. Culver City, California
01730 Replaced by 73586	04009 Arrow Hart Inc. Hartford, Connecticut	05704 Replaced by 16258	07263 Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California
01884 Use 56289 Sprague Electric Co. Dearborn Electronic Div. Lockwood, Florida	04062 Replaced by 72136	05820 Wakefield Engineering Inc. Wakefield, Massachusetts	07344 Bircher Co., Inc. Rochester, New York
02114 Ferroxcube Corp. Saugerties, New York	04202 Replaced by 81312	06001 General Electric Co. Electronic Capacitor & Battery Products Dept. Columbia, South Carolina	07597 Burndy Corp. Tape/Cable Div. Rochester, New York
02131 General Instrument Corp. Harris ASW Div. Westwood, Maine	04217 Essex International Inc. Wire & Cable Div. Anaheim, California	06136 Replaced by 63743	07792 Lerma Engineering Corp. Northampton, Massachusetts
02395 Rason Mfg. Co. Brooklyn, New York	04221 Aemco, Div. of Midtex Inc. Mankato, Minnesota	06383 Panduit Corp. Tinley Park, Illinois	07910 Teledyne Semiconductor Formerly Continental Device Hawthorne, California
02533 Snelgrove, C.R. Co., Ltd. Don Mills, Ontario, Canada M3B 1M2	04222 AVX Ceramics Div. AVX Corp. Myrtle Beach, Florida	06473 Bunker Ramo Corp. Amphenol SAMS Div. Chatsworth, California	07933 Use 49956 Raytheon Co. Semiconductor Div. HQ Mountain View, California
02606 Fenwal Labs Div. of Travenal Labs. Morton Grove, Illinois	04423 Telonic Industries Laguna Beach, California	06555 Beede Electrical Instrument Co. Penacook, New Hampshire	08225 Industro Transistor Corp. Long Island City, New York
	04645 Replaced by 75376	06739 Electron Corp. Littleton, Colorado	
	04713 Motorola Inc. Semiconductor Products Phoenix, Arizona	06743 Clevite Corp. Cleveland, Ohio	

Federal Supply Codes for Manufacturers (cont)

08261 Spectra Strip Corp. Garden Grove, California	11726 Qualidyne Corp. Santa Clara, California	13606 Use 56289 Sprague Electric Co. Transistor Div. Concord, New Hampshire	16299 Corning Glass Electronic Components Div. Raleigh, North Carolina
08530 Reliance Mica Corp. Brooklyn, New York	12014 Chicago Rivet & Machine Co. Bellwood, Illinois	13839 Replaced by 23732	16332 Replaced by 28478
08806 General Electric Co. Miniature Lamp Products Dept Cleveland, Ohio	12040 National Semiconductor Corp. Danbury, Connecticut	14099 Semtech Corp. Newbury Park, California	16473 Cambridge Scientific Ind. Div. of Chemed Corporation Cambridge, Maryland
08863 Nylomatic Corp. Norrisville, Pennsylvania	12060 Diodes, Inc. Chatsworth, California	14140 Edison Electronic Div. Mc Gray-Edison Co. Manchester, New Hampshire	16742 Paramount Plastics Fabricators, Inc. Downey, California
08988 Use 53085 Skottie Electronics Inc. Archbald, Pennsylvania	12136 Philadelphia Handle Co. Camden, New Jersey	14193 Cal-R-Inc. formerly California Resistor, Corp. Santa Monica, California	16758 Delco Electronics Div. of General Motors Corp. Kokomo, Indiana
09214 G. E. Co. Semi-Conductor Products Dept. Power Semi-Conductor Products OPN Sec. Auburn, New York	12300 Potter-Brumfield Div. AMF Canada LTD. Guelph, Ontario, Canada	14298 American Components, Inc. an Insilco Co. Conshohocken, Pennsylvania	17001 Replaced by 71468
09353 C and K Components Watertown, Massachusetts	12323 Presin Co., Inc. Shelton, Connecticut	14655 Cornell-Dublier Electronics Division of Federal Pacific Electric Co. Govt. Control Dept. Newark, New Jersey	17069 Circuit Structures Lab. Burbank, California
09423 Scientific Components, Inc. Santa Barbara, California	12327 Freeway Corp. formerly Freeway Washer & Stamping Co. Cleveland, Ohio	14752 Electro Cube Inc. San Gabriel, California	17338 High Pressure Eng. Co., Inc. Oklahoma City, Oklahoma
09922 Burndy Corp. Norwalk, Connecticut	12443 The Budd Co. Polychem Products Plastic Products Div. Bridgeport, Pennsylvania	14869 Replaced by 96853	17545 Atlantic Semiconductors, Inc. Asbury Park, New Jersey
09969 Dale Electronics Inc. Yankton, S. Dakota	12615 U.S. Terminals Inc. Cincinnati, Ohio	14936 General Instrument Corp. Semi Conductor Products Group Hicksville, New York	17856 Siliconix, Inc. Santa Clara, California
10059 Barker Engineering Corp. Formerly Amerace, Amerace ESNA Corp. Kenilworth, New Jersey	12617 Hamlin Inc. Lake Mills, Wisconsin	15636 Elec-Trol Inc. Saugus, California	17870 Replaced by 14140
11236 CTS of Berne Berne, Indiana	12697 Clarostat Mfg. Co. Dover, New Hampshire	15801 Fenwal Electronics Inc. Div. of Kidde Walter and Co., Inc. Framingham, Massachusetts	18178 Vactec Inc. Maryland Heights, Missouri
11237 CTS Keene Inc. Paso Robles, California	12749 James Electronics Chicago, Illinois	15818 Teledyne Semiconductors, formerly Amelco Semiconductor Mountain View, California	18324 Signetics Corp. Sunnyvale, California
11358 CBS Electronic Div. Columbia Broadcasting System Newburyport, Minnesota	12856 Micrometals Sierra Madre, California	15849 Litton Systems Inc. Useco Div. formerly Useco Inc. Van Nuys, California	18612 Vishay Resistor Products Div. Vishay Intertechnology Inc. Malvern, Pennsylvania
11403 Best Products Co. Chicago, Illinois	12954 Dickson Electronics Corp. Scottsdale, Arizona	15898 International Business Machines Corp. Essex Junction, Vermont	18736 Voltronics Corp. Hanover, New Jersey
11503 Keystone Columbia Inc. Warren, Michigan	12969 Unitrode Corp. Watertown, Massachusetts	15909 Replaced by 14140	18927 GTE Sylvania Inc. Precision Material Group Parts Division Titusville, Pennsylvania
11532 Teledyne Relays Hawthorne, California	13103 Thermalloy Co., Inc. Dallas, Texas	16258 Space-Lok Inc. Burbank, California	19451 Perine Machinery & Supply Co. Seattle, Washington
11711 General Instrument Corp. Rectifier Division Hicksville, New York	13327 Solitron Devices Inc. Tappan, New York		19701 Electro-Midland Corp. Mepco-Electra Inc. Mineral Wells, Texas
	13511 Amphenol Cadre Div. Bunker-Ramo Corp. Los Gatos, California		20584 Enochs Mfg. Inc. Indianapolis, Indiana

Federal Supply Codes for Manufacturers (cont)

20891 Self-Organizing Systems, Inc. Dallas, Texas	28480 Hewlett Packard Co. Corporate HQ Palo Alto, California	43543 Nytronics Inc. Transformer Co. Div. Geneva, New York	70903 Belden Corp. Geneva, Illinois
21604 Bucheys Stamping Co. Columbus, Ohio	28520 Heyman Mfg. Co. Kenilworth, New Jersey	44655 Ohmite Mfg. Co. Skokie, Illinois	71002 Birnbach Radio Co., Inc. Freeport, New York
21845 Solitron Devices Inc. Transistor Division Riviera Beach, Florida	29083 Monsanto, Co., Inc. Santa Clara, California	49671 RCA Corp. New York, New York	71400 Bussmann Mfg. Div. of McGraw-Edison Co. Saint Louis, Missouri
22767 ITT Semiconductors Palo Alto, California	29604 Stackpole Components Co. Raleigh, North Carolina	49956 Raytheon Company Lexington, Massachusetts	71450 CTS Corp. Elkhart, Indiana
23050 Product Comp. Corp. Mount Vernon, New York	30148 AB Enterprise Inc. Ahoskie, North Carolina	50088 Mostek Corp. Carrollton, Texas	71468 ITT Cannon Electric Inc. Santa Ana, California
23732 Tracor Inc. Rockville, Maryland	30323 Illinois Tool Works, Inc. Chicago, Illinois	50579 Litronix Inc. Cupertino, California	71482 Clare, C.P. & Co. Chicago, Illinois
23880 Stanford Applied Engrng. Santa Clara, California	31091 Optimax Inc. Colmar, Pennsylvania	51605 Scientific Components Inc. Linden, New Jersey	71590 Centrelab Electronics Div. of Globe Union Inc. Milwaukee, Wisconsin
23936 Pamotor Div., Wm. J. Purdy Co. Burlingame, California	32539 Mura Corp. Great Neck, New York	53021 Sangamo Electric Co. Springfield, Illinois	71707 Coto Coil Co., Inc. Providence, Rhode Island
24248 Replaced by 94222	32767 Griffith Plastic Corp. Burlingame, California	54294 Cutler-Hammer Inc. formerly Shallcross, A Cutter-Hammer Co. Selma, North Carolina	71744 Chicago Miniature Lamp Works Chicago, Illinois
24355 Analog Devices Inc. Norwood, Massachusetts	32879 Advanced Mechanical Components Northridge, California	55026 Simpson Electric Co. Div. of Am. Gage and Mach. Co. Elgin, Illinois	71785 TRW Electronics Components Cinch Connector Operations Div. Elk Grove Village Chicago, Illinois
24655 General Radio Concord, Massachusetts	32897 Erie Technological Products, Inc. Frequency Control Div. Carlisle, Pennsylvania	56289 Sprague Electric Co. North Adams, Massachusetts	72005 Wilber B. Driver Co. Newark, New Jersey
24759 Lenox-Fugle Electronics Inc. South Plainfield, New Jersey	32997 Bourns Inc. Trimpot Products Division Riverside, California	58474 Superior Electric Co. Bristol, Connecticut	72092 Replaced by 06980
25088 Siemen Corp. Isilen, New Jersey	33173 General Electric Co. Products Dept. Owensboro, Kentucky	60399 Torin Corp. formerly Torrington Mfg. Co. Torrington, Connecticut	72136 Electro Motive Mfg. Co. Williamantic, Connecticut
25403 Amperex Electronic Corp. Semiconductor & Micro-Circuits Div. Slatersville, Rhode Island	34333 Silicon General Westminister, California	63743 Ward Leonard Electric Co., Inc. Mount Vernon, New York	72259 Nytronics Inc. Pelham Manor, New Jersey
27014 National Semiconductor Corp. Santa Clara, California	34335 Advanced Micro Devices Sunnyvale, California	64834 West Mfg. Co. San Francisco, California	72619 Dialight Div. Amperex Electronic Corp. Brooklyn, New York
27264 Molex Products Downers Grove, Illinois	34802 Electromotive Inc. Kenilworth, New Jersey	65092 Weston Instruments Inc. Newark, New Jersey	72653 G.C. Electronics Div. of Hydrometals, Inc. Brooklyn, New York
28213 Minnesota Mining & Mfg. Co. Consumer Products Div. St. Paul, Minnesota	37942 P.R. Mallory & Co., Inc. Indianapolis, Indiana	66150 Winslow Tele-Tronics Inc. Eaton Town, New Jersey	72665 Replaced by 90303
28425 Serv-/Link formerly Bohannon Industries Fort Worth, Texas	42498 National Radio Melrose, Massachusetts	70485 Atlantic India Rubber Works Chicago, Illinois	72794 Dzus Fastener Co., Inc. West Islip, New York
28478 Deltrol Controls Div. Deltrol Corporation Milwaukee, Wisconsin		70563 Amperite Company Union City, New Jersey	72928 Gulton Ind. Inc. Gudeman Div. Chicago, Illinois

Federal Supply Codes for Manufacturers (cont)

72982 Erie Tech. Products Inc. Erie, Pennsylvania	75382 Kulka Electric Corp. Mount Vernon, New York	80583 Hammarlund Mfg. Co., Inc. Red Bank, New Jersey	83594 Burroughs Corp. Electronic Components Div. Plainfield, New Jersey
73138 Bechman Instrument Inc. Helipot Division Fullerton, California	75915 Littlefuse Inc. Des Plaines, Illinois	80640 Arnold Stevens, Inc. South Boston, Massachusetts	83740 Union Carbide Corp. Battery Products Div. formerly Consumer Products Div. New York, New York
73293 Hughes Aircraft Co. Electron Dynamics Div. Torrance, California	76854 Oak Industries Inc. Switch Div. Crystal Lake, Illinois	81073 Grayhill, Inc. La Grange, Illinois	84171 Arco Electronics Great Neck, New York
73445 Amperex Electronic Corp. Hicksville, New York	77342 AMF Inc. Potter & Brumfield Div. Princeton, Indiana	81312 Winchester Electronics Div. of Litton Industries Inc. Oakville, Connecticut	84411 TRW Electronic Components TRW Capacitors Ogallala, Nebraska
73559 Carling Electric Inc. West Hartford, Connecticut	77638 General Instrument Corp. Rectifier Division Brooklyn, New York	81483 Therm-O-Disc Inc. Mansfield, Ohio	84613 Fuse Indicator Corp. Rockville, Maryland
73586 Circle F Industries Trenton, New Jersey	77969 Rubbercraft Corp. of CA. LTD. Torrance, California	81483 International Rectifier Corp. Los Angeles, California	84682 Essex International Inc. Industrial Wire Div. Peabody, Massachusetts
73734 Federal Screw Products, Inc. Chicago, Illinois	78189 Shakeproof Div. of Illinois Tool Works Inc. Elgin, Illinois	81590 Korrry Mfg. Co. Seattle, Washington	86577 Precision Metal Products of Malden Inc. Stoneham, Massachusetts
73743 Fischer Special Mfg. Co. Cincinnati, Ohio	78277 Sigma Instruments, Inc. South Braintree, Massachusetts	81741 Chicago Lock Co. Chicago, Illinois	86684 Radio Corp. of America Electronic Components Div. Harrison, New Jersey
73899 JFD Electronics Co. Components Corp. Brooklyn, New York	78488 Stackpole Carbon Co. Saint Marys, Pennsylvania	82305 Palmer Electronics Corp. South Gate, California	86928 Seastrom Mfg. Co., Inc. Glendale, California
73949 Guardian Electric Mfg. Co. Chicago, Illinois	78553 Eaton Corp. Engineered Fastener Div. Tinnerman Plant Cleveland, Ohio	82389 Switchcraft Inc. Chicago, Illinois	87034 Illuminated Products Inc. Subsidiary of Oak Industries Inc. Anahiem, California
74199 Quan Nichols Co. Chicago, Illinois	79136 Waldes Kohinoor Inc. Long Island City, New York	82415 North American Phillips Controls Corp. Frederick, Maryland	88219 Gould Inc. Industrial Div. Trenton, New Jersey
74217 Radio Switch Corp. Marlboro, New Jersey	79497 Western Rubber Company Goshen, Indiana	82872 Roanwell Corp. New York, New York	88245 Litton Systems Inc. Uesco Div. Van Nuys, California
74276 Signalite Div. General Instrument Corp. Neptune, New Jersey	79963 Zierick Mfg. Corp. Mt. Kisko, New York	82877 Rotron Inc. Woodstock, New York	88419 Cornell-Dubilier Electronic Div. Federal Pacific Co. Fuquay-Varian, North Carolina
74306 Piezo Crystal Co. Carlisle, Pennsylvania	80031 Electro-Midland Corp. Mepco Div. A North American Phillips Co. Norristown, New Jersey	82879 ITT Royal Electric Div. Pawtucket, Rhode Island	88486 Plastic Wire & Cable Jewitt City, Connecticut
74542 Hoyt Elect. Instr. Works Penacook, New Hampshire	80145 LFE Corp., Process Control Div. formerly API Instrument Co. Chesterland, Ohio	83003 Varo Inc. Garland, Texas	88690 Replaced by 04217
74970 Johnson E.F., Co. Waseca, Minnesota	80183 Use 56289 Sprague Products North Adams, Massachusetts	83058 The Carr Co., United Can Div. of TRW Cambridge, Massachusetts	89536 John Fluke Mfg. Co., Inc. Seattle, Washington
75042 TRW Electronics Components IRC Fixed Resistors Philadelphia, Pennsylvania	80294 Bourns Inc., Instrument Div. Riverside, California	83298 Bendix Corp. Electric Power Div. Eatontown, New Jersey	89730 G.E. Co., Newark Lamp Works Newark, New Jersey
75376 Kurz-Kasch Inc. Dayton, Ohio		83330 Herman H. Smith, Inc. Brooklyn, New York	
75378 CTS Knights Inc. Sandwich, Illinois		83478 Rubbercraft Corp. of America, Inc. West Haven, Connecticut	

Federal Supply Codes for Manufacturers (cont)

90201 Mallory Capacitor Co. Div. of P.R. Mallory Co., Inc. Indianapolis, Indiana	91836 King's Electronics Co., Inc. Tuckahoe, New York	95354 Methode Mfg. Corp. Rolling Meadows, Illinois	98291 Sealectro Corp. Mamaroneck, New York
90211 Use 56365 Square D Co. Chicago, Illinois	91929 Honeywell Inc. Micro Switch Div. Freeport, Illinois	95712 Bendix Corp. Electrical Components Div. Microwave Devices Plant Franklin, Indiana	98388 Royal Industries Products Div. San Diego, California
90215 Best Stamp & Mfg. Co. Kansas City, Missouri	91934 Miller Electric Co., Inc. Div. of Aunet Woonsocket, Rhode Island	95987 Weckesser Co. Inc. Chicago, Illinois	98743 Replaced by 12749
90303 Mallory Battery Co. Div. of Mallory Co., Inc. Tarrytown, New York	92194 Alpha Wire Corp. Elizabeth, New Jersey	96733 San Fernando Electric Mfg. Co. San Fernando, California	98925 Replaced by 14433
91094 Essex International Inc. Suglex/IWP Div. Newmarket, New Hampshire	93332 Sylvania Electric Products Semiconductor Products Div. Woburn, Massachusetts	96853 Gulton Industries Inc. Measurement and Controls Div. formerly Rustrak Instruments Co. Manchester, New Hampshire	99120 Plastic Capacitors, Inc. Chicago, Illinois
91293 Johanson Mfg. Co. Boonton, New Jersey	94145 Replaced by 49956	96881 Thomson Industries, Inc. Manhasset, New York	99217 Bell Industries Elect. Comp. Div. formerly Southern Elect. Div. Burbank, California
91407 Replaced by 58474	94154 Use 94988 Wagner Electric Corp. Tung-Sol Div. Newark, New Jersey	97540 Master Mobile Mounts, Div. of Whitehall Electronics Corp. Ft. Meyers, Florida	99392 STM Oakland, California
91502 Associated Machine Santa Clara, California	94222 Southco Inc. formerly South Chester Corp. Lester, Pennsylvania	97913 Industrial Electronic Hardware Corp. New York, New York	99515 ITT Jennings Monrovia Plant Div. of ITT Jennings formerly Marshall Industries Capacitor Div. Monrovia, California
91506 Augat Inc. Attleboro, Massachusetts	95146 Alco Electronic Products Inc. Lawrence, Massachusetts	97945 Penwalt Corp. SS White Industrial Products Div. Piscataway, New Jersey	99779 Use 29587 Bunker-Ramo Corp. Barnes Div. Landsdowne, Pennsylvania
91637 Dale Electronics Inc. Columbus, Nebraska	95263 Leecraft Mfg. Co. Long Island City, New York	97966 Replaced by 11358	99800 American Precision Industries Inc. Delevan Division East Aurora, New York
91662 Elco Corp. Willow Grove, Pennsylvania	95264 Replaced by 98278	98094 Replaced by 49956	99942 Centrelab Semiconductor Centrelab Electronics Div. of Globe-Union Inc. El Monte, California
91737 Use 71468 Gremar Mfg. Co., Inc. ITT Cannon/Gremar Santa Ana, California	95275 Vitramon Inc. Bridgeport, Connecticut	98159 Rubber-Teck, Inc. Gardena, California	Toyo Electronics (R-Ohm Corp.) Irvine, California
91802 Industrial Devices, Inc. Edgewater, New Jersey	95303 RCA Corp. Receiving Tube Div. Cincinnati, Ohio	98278 Malco A Microdot Co., Inc. Connector & Cable Div. Pasadena, California	National Connector Minneapolis, Minnesota
91833 Keystone Electronics Corp. New York, New York	95348 Gordo's Corp. Bloomfield, New Jersey		

U.S. SALES AREAS for all Fluke products

AL, Huntsville

John Fluke Mfg. Co., Inc.
4920 Corporate Drive
Suite J
Huntsville, AL 35805-6202
(205) 830-9671

AZ, Tempe

John Fluke Mfg. Co., Inc.
2211 S. 48th Street
Suite B
Tempe, AZ 85282
(602) 438-8314

CA, Burbank

John Fluke Mfg. Co., Inc.
2020 N. Lincoln Street
Burbank, CA 91504
(213) 849-7181

Irvine

P.O. Box 19676
Irvine, CA 92713-9676
16969 Von Karman
Suite 100
Irvine, CA 92714
(714) 863-9031

San Diego

John Fluke Mfg. Co., Inc.
4540 Kearny Villa Road
Suite 115
San Diego, CA 92123
(619) 292-7656

Santa Clara

John Fluke Mfg. Co., Inc.
2300 Walsh Ave., Bldg. K
Santa Clara, CA 95051
(408) 727-0513

CO, Denver

John Fluke Mfg. Co., Inc.
14180 E. Evans Ave.
Aurora, CO 80014
(303) 695-1000

CT, Hartford

John Fluke Mfg. Co., Inc.
Glen Lochen East
41-C New London Turnpike
Glastonbury, CT 06033
(203) 659-3541

FL, Clearwater

(813) 799-0087

Orlando

John Fluke Mfg. Co., Inc.
940 N. Fern Creek Ave.
Orlando, FL 32803
(305) 896-4881

Tampa

(813) 251-9211

GA, Atlanta

John Fluke Mfg. Co., Inc.
2600 Delk Road
Suite 150
Marietta, GA 30067
(404) 953-4747

IL, Chicago

John Fluke Mfg. Co., Inc.
1150 W. Euclid Avenue
Palatine, IL 60067
(312) 398-0850
(312) 392-9510

IN, Indianapolis

John Fluke Mfg. Co., Inc.
8777 Purdue Road
Suite 101
Indianapolis, IN 46268
(317) 875-7870

MA, Billerica

John Fluke Mfg. Co., Inc.
900 Middlesex Turnpike
Building 8
Billerica, MA 01821
(617) 663-2400

MD, Baltimore

(301) 792-7060

Rockville

John Fluke Mfg. Co., Inc.
5640 Fishers Lane
Rockville, MD 20852
(301) 770-1570

MI, Detroit

John Fluke Mfg. Co., Inc.
33031 Schoolcraft
Livonia, MI 48150
(313) 522-9140

MN, Bloomington

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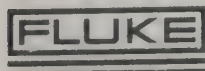
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Fluke (Nederland) B.V.
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New Zealand, Auckland

McLean Information Technology, Ltd.
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TLX: (791) 21570

Norway, Oslo

Morgenstjerne & Co. A/S
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TLX: (856) 71719

Pakistan, Karachi

International Operations (PAK), Ltd.
Tel: 221127, 239052
TLX: (952) 24494

Peru, Lima

Importaciones Y Representaciones
Electronicas S.A.
Tel: 288650
TLX: (394) 25663

Philippines, Republic of

Spark Radio & Electronics Corp.
Tel: 775192
TLX: (722) 27901

Portugal, Lisbon

Decada Espectral Equipamentos
de Electronica, Lda.
Tel: 2103420
TLX: (832) 15515

Republic of Singapore, Singapore

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Coasin Uruguay S.A.
Tel: 789015
TLX: (398) UY23010

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Tel: 239-0967
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Section 8

Schematic Diagrams

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List of Mnemonics

ACK	— acknowledge
ACK LAT	— acknowledge late
AR	— analog return
DB	— data bus
DBIN	— data bus input signal (from μ P)
DLD ACK	— delayed ACK
EN INT	— enable interrupt
HLDA	— hold acknowledge
IB ADX	— interbus address
IBIN	— interbus input signal
IC	— interbus control
ID	— interbus data
IINT	— internal interrupt
INA	— interrupt acknowledge (from controller)
INT	— interrupt
INTA	— Interrupt acknowledge (status word from μ P)
INTE	— interrupt enable (from μ P)
MEM RD	— memory read
MS ADDR BYTE	— memory select address byte
$\phi 1$	— clock pulse
$\phi 2$	— clock pulse
ϕLL	— phase-locked loop
RAM	— random access memory
ROM	— read only memory
RRDY	— reset ready
RST	— reset
RT	— real time
R/W	— read/write
μ P	— microprocessor
VA	— analog supply voltage
$V_{CC} \phi 2$	— 5V clock pulse
$V_{DD} \phi 2$	— 12V clock pulse
SRDY	— set ready
SYN IINT	— synchronized internal interrupt
TTL PU	— TTL pull-up
WO	— write out
WR	— write

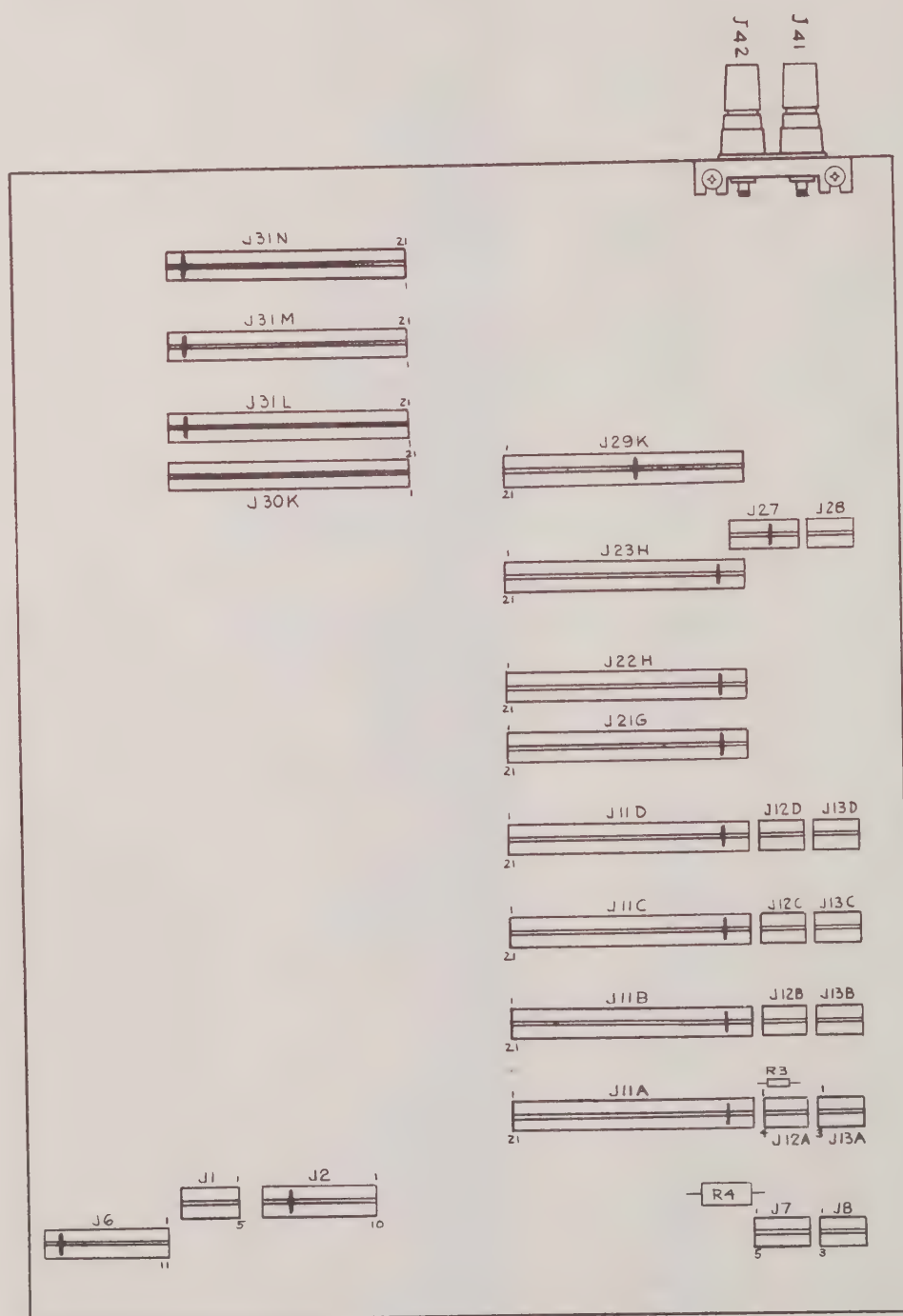
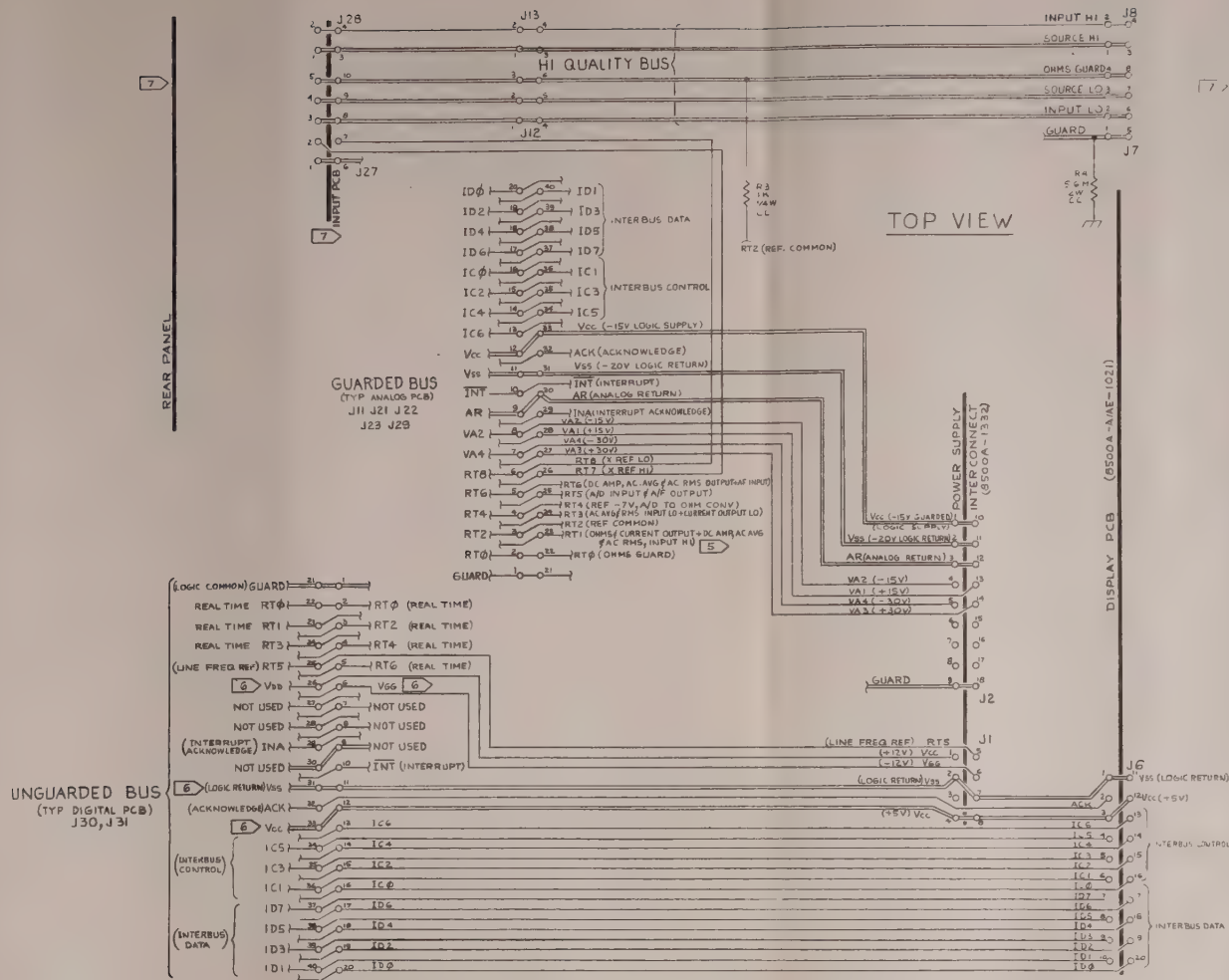


Figure 8-1. A2 Motherboard PCB Assembly



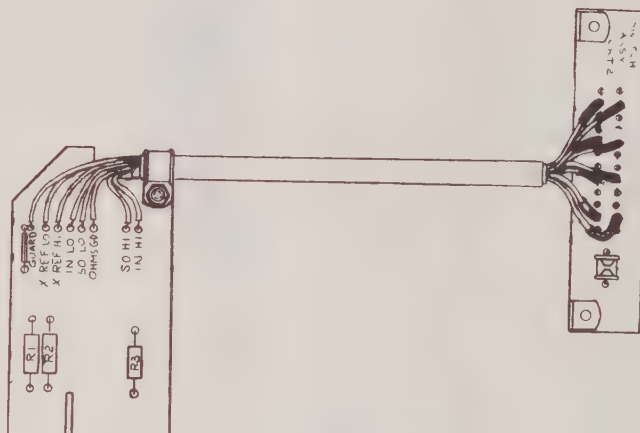
NOTES.

- 1 FOR MOTHER PCB SEE 8500A-1001
- 2 FOR MOTHER ASSY SEE 8500A/AE-1001
- 3 FOR REF DES DWG SEE 8500A/AE-1001
- 4 FOR INTERCONNECT DIAGRAM SEE 8500A-1301
- 5 THIS BUS LINE IS INTERCONNECTED ON J21, J22, J23 & J29 BUT HAS NO USE ON 8500A APPLICATIONS IN THESE LOCATIONS. FUNCTION INDICATED 5 FOR J11 ONLY. NO INTERCONNECT EXISTS BETWEEN J11, PIN23 & OTHER CONNECTORS ON GUARDED BUS FUNCTION WILL VARY DEPENDING UPON BUS INTER-CONNECTION INSTALLED IN UNIT.
- 6 CONNECTION BETWEEN INPUT PCB (J27 & J28) AND FRONT- OR REAR-PANEL (SELECTED BY SWITCH) SEE SHEET 2.

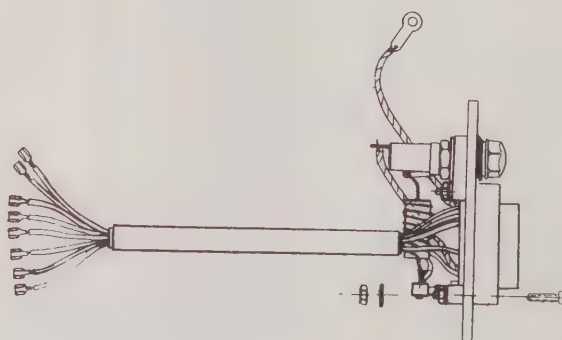
FUNCTION	ISOLATOR (OPTION-08)	BUS INTERCONNECT (MHS-1001)
VSS	0	-20V
VDD	+12V	-8V
VGG	-12V	-32V
VCC	+5V	-15V

8500A/AE-1001

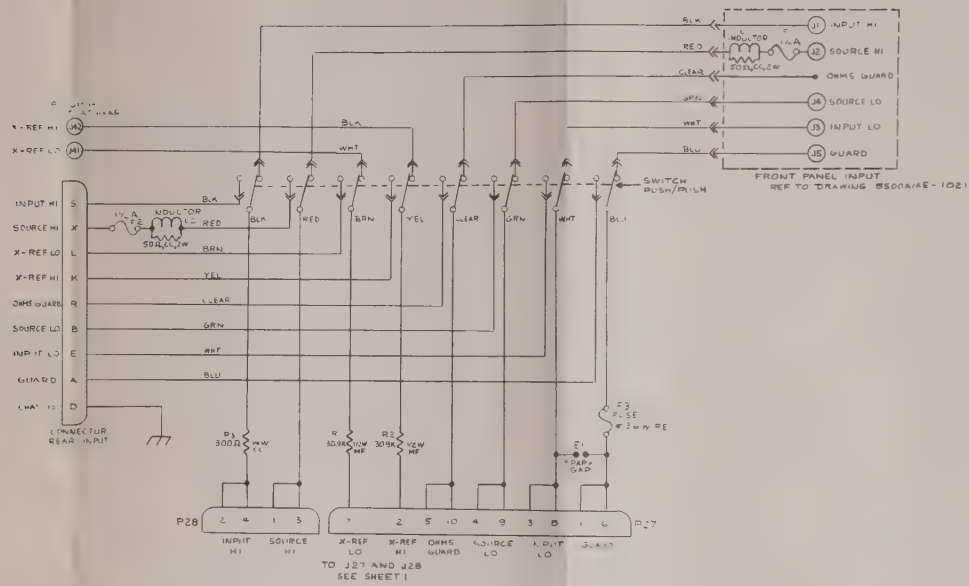
Figure 8-1. A2 Motherboard PCB Assembly (cont)



Input Switch Assembly (8500A/AE-4414)



Rear Input Assembly (8500A/AE-4413)



8500A/AE-1001

Figure 8-1. A2 Motherboard PCB Assembly (cont)

FUNCTION TABLE			FUNCTION TABLE			FUNCTION TABLE			
CONNECTOR	PIN NO	FUNCTION	CONNECTOR	PIN NO	FUNCTION	CONNECTOR	PIN NO	FUNCTION	
J1 (Unpopulated Bus)	1	+12V Vcc	J15A (Guarded Bus)	17	106 Interbus Data	J25K (Guarded Bus)	21	Guard	
	2	Vcc Logic Return		18	104 Interbus Data		22	RTD Ohm's Guard	
	3	NC		19	102 Interbus Data		23	11	
	4	+15V Vcc		20	100 Interbus Data		24	RTS AE, Analog RMS Input Lo + Current Output Lo	
	5	RTS (Line Freq Ref 1)		21	Guard		25	RTS A/D Input & A/F Output	
	6	+12V Vcc		22	RTD Ohm's Guard		26	RTS X Ref Hi	
	7	Vcc Logic Return		23	RTD Ohm's Guard		27	+10V VAS	
	8	+5V Vcc		24	RTD Ohm's Guard		28	+15V VAI	
	J21 (Guarded Bus)	1		+15V Vcc Logic Supply	25		RTS A/F Input & A/F Output	29	10A Interrupt Acknowledge
		2		+20V Vcc Logic Return	26		RTS X Ref Hi	30	AR Analog Return
3		AR Analog Return	27	+10V VAS	31	+10V Vcc Logic Return			
4		+15V VAI	28	+15V VAI	32	ACE Acknowledge			
5		+10V VAI	29	10A Interrupt Acknowledge	33	+15V Vcc Logic Supply			
6		NC	30	AR Analog Return	34	ICS Interbus Control			
7		NC	31	+10V Vcc Logic Return	35	ICS Interbus Control			
8		NC	32	ACE Acknowledge	36	ICS Interbus Control			
9		Guard	33	+15V Vcc Logic Supply	37	107 Interbus Data			
10		+15V Vcc Logic Return	34	ICS Interbus Control	38	105 Interbus Data			
11		+20V Vcc Logic Supply	35	ICS Interbus Control	39	103 Interbus Data			
12		AR Analog Return	36	ICS Interbus Control	40	101 Interbus Data			
13		+15V VAI	37	107 Interbus Data	J30K (Unpopulated Bus)	1	Guard Logic Common		
14		+10V VAI	38	105 Interbus Data		2	RTD Real Time 0		
15		NC	39	103 Interbus Data		3	RTD Real Time 1		
16		NC	40	101 Interbus Data		4	RTD Real Time 2		
17		NC				5	RTD Real Time 3		
18		Guard				6	RTD Real Time 4		
J26 (Unpopulated Bus)	1	Vcc (Logic Return)	J32A (Design Quality Bus)	1		Input Lo	7	Vcc	
	2	ACK (Acknowledge)		2		Source Lo	8	NC	
	3	+5V Vcc		3		Ohm's Guard	9	NC	
	4	ICS (Interbus Control)		4		Input Lo	10	NC	
	5	ICS (Interbus Control)		5		Source Lo	11	ICS Interbus not	
	6	ICS (Interbus Control)		6		Ohm's Guard	12	Vcc	
	7	107 Interbus Data		7		Source Hi	13	ICS Interbus Control	
	8	105 Interbus Data		8		Input Hi	14	ICS Interbus Control	
	9	103 Interbus Data		9		Source Hi	15	ICS Interbus Control	
	10	101 Interbus Data		10		Input Hi	16	ICS Interbus Control	
11	Vcc Logic Return	11	Guard	17		106 Interbus Data			
12	+5V Vcc	12	X Ref Hi	18		104 Interbus Data			
13	IC6 (Interbus Control)	13	Input Lo	19		102 Interbus Data			
14	IC4 (Interbus Control)	14	Source Lo	20		100 Interbus Data			
15	IC2 (Interbus Control)	15	Ohm's Guard	21		Guard Logic Common			
16	IC0 (Interbus Control)	16	Guard	22		RTD Real Time 0			
17	106 Interbus Data	17	X Ref Lo	23		RTD Real Time 1			
18	104 Interbus Data	18	Input Lo	24		RTD Real Time 2			
19	102 Interbus Data	19	Source Lo	25		RTD Real Time 3			
20	100 Interbus Data	20	Ohm's Guard	26		RTD Real Time 4			
J27 (Design Quality Bus)	1	Guard	J32B (Design Quality Bus)	1	Source Hi	J32C (Design Quality Bus)	1	Guard	
	2	Input Lo		2	Input Hi		2	Input Lo	
	3	Source Lo		3	Source Hi		3	Source Lo	
	4	Ohm's Guard		4	Input Hi		4	Ohm's Guard	
	5	Guard		5	Guard		5	Guard	
	6	Input Lo		6	Source Hi		6	Input Lo	
	7	Source Lo		7	Input Hi		7	Source Lo	
	8	Ohm's Guard		8	Guard		8	Ohm's Guard	
J28 (Design Quality Bus)	1	Source Hi	J21C (Guarded Bus)	1	RTD Ohm's Guard	J25K (Guarded Bus)	1	Vcc	
	2	Input Hi		2	RTD Ref Common		2	+15V Vcc	
	3	Source Hi		3	RTD Ref Common		3	+10V VAI	
	4	Input Hi		4	RTD Ref Common		4	+5V Vcc	
J31A J31B J31C J31D (Guarded Bus)	1	Guard	J32A (Guarded Bus)	1	Source Hi	J32B (Guarded Bus)	1	Source Hi	
	2	RTD Ohm's Guard		2	Input Hi		2	Input Hi	
	3	RTD Ref Common		3	Source Hi		3	Source Hi	
	4	RTD Ref Common		4	Input Hi		4	Input Hi	
	5	RTD Ref Common		5	Source Hi		5	Source Hi	
	6	RTD Ref Common		6	Input Hi		6	Input Hi	
	7	RTD Ref Common		7	Source Hi		7	Source Hi	
	8	RTD Ref Common		8	Input Hi		8	Input Hi	
	9	RTD Ref Common		9	Source Hi		9	Source Hi	
	10	RTD Ref Common		10	Input Hi		10	Input Hi	
	11	RTD Ref Common		11	Source Hi		11	Source Hi	
	12	RTD Ref Common		12	Input Hi		12	Input Hi	
	13	RTD Ref Common		13	Source Hi		13	Source Hi	
	14	RTD Ref Common		14	Input Hi		14	Input Hi	
	15	RTD Ref Common		15	Source Hi		15	Source Hi	
	16	RTD Ref Common		16	Input Hi		16	Input Hi	

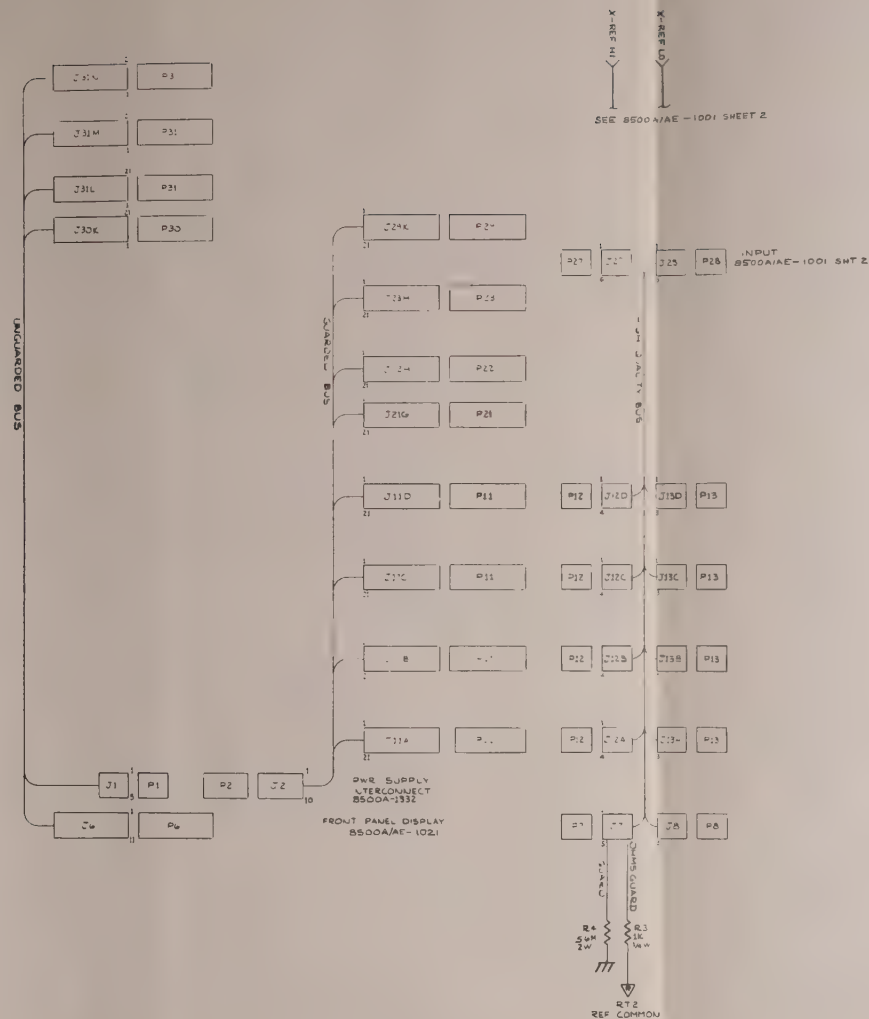
11 This Bus Item is not used for 8500A applications, but it is interconnected on J31A, J31B, J31C, & J31D. Its connection is made with J31 Pin 23.

12 Functions will vary depending upon type of bus interconnection installed in unit.

Function	Interconnect (Option 00)	Bus Interconnect (Misc-1001)
Vcc	0	+10V
Vdd	+12V	-0V
Vpp	+12V	+12V
Vcc	+5V	+15V

8500A/AE-1301

Figure 8-2. Interconnect Diagram Mother Assembly

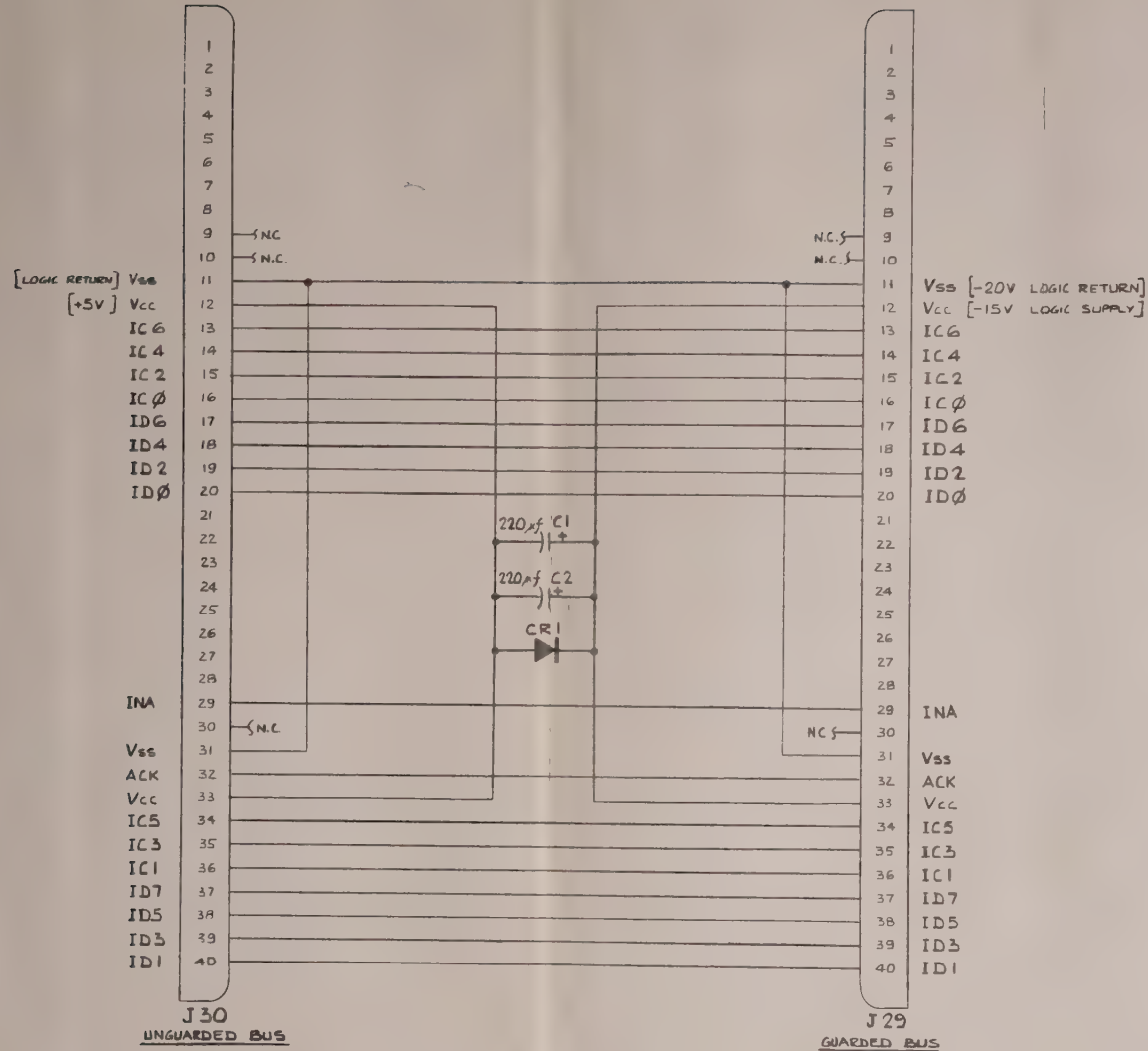


MODULE INSTALLATION LOCATIONS			
MODULE DESCRIPTION	SCHEMATIC DWG NO.	PREFERRED SLOT	PERMISSIBLE SLOTS
D.C. SIGNAL COND.	N.I.S.-1101	A	A B C D
DC REG. CONV. (OPTION -01)	N.I.S.-1101	B	A B C D
D.C. S. CONV. (OPTION -02)	N.I.S.-1101	B	A B C D
CURRENT SENSE (OPTION -03)	N.I.S.-1101	C	A B C D
DWMS CONV. (OPTION -02)	N.I.S.-1110	D	A B C D
FILTER	N.I.S.-1130	G	G
A/D CONV.	N.I.S.-1140 N.I.S.-1141	H	H
BUS INTERCONNECT	N.I.S.-1081	K	K
ISOLATOR (OPTION -08)	N.I.S.-1181	K	K
CONTROLLER	N.I.S.-1185	N (NOT INSTALLED)	L M N
CALIBRATION MEMORY (OPTION -04)	N.I.S.-1160	M	L M N
BIT SERIAL (OPTION -06)	N.I.S.-1170	N	L M N
PARALLEL INTERFACE (OPTION -07)	N.I.S.-1171	N	L M N
IEEE INTERFACE (OPTION -05)	N.I.S.-1022 N.I.S.-1172	N	L M N

SERVICE / FIELD AIDS - LOCATIONS			
DESCRIPTION	SCHEMATIC DWG NO.	PREFERRED SLOT	PERMISSIBLE SLOTS
ACTIVE CONTROLLER	N.I.S.-1160	L M N	A B C D L M N
TEST MODULE	N.I.S.-1114	A B C D	A B C D L M N
EXTENDER	N.I.S.-1014	NONE	ANY
BUS INTERCONNECT & MONITOR	N.I.S.-1014	A	ANY

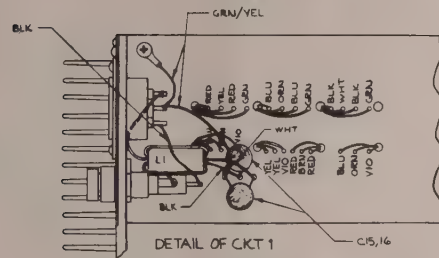
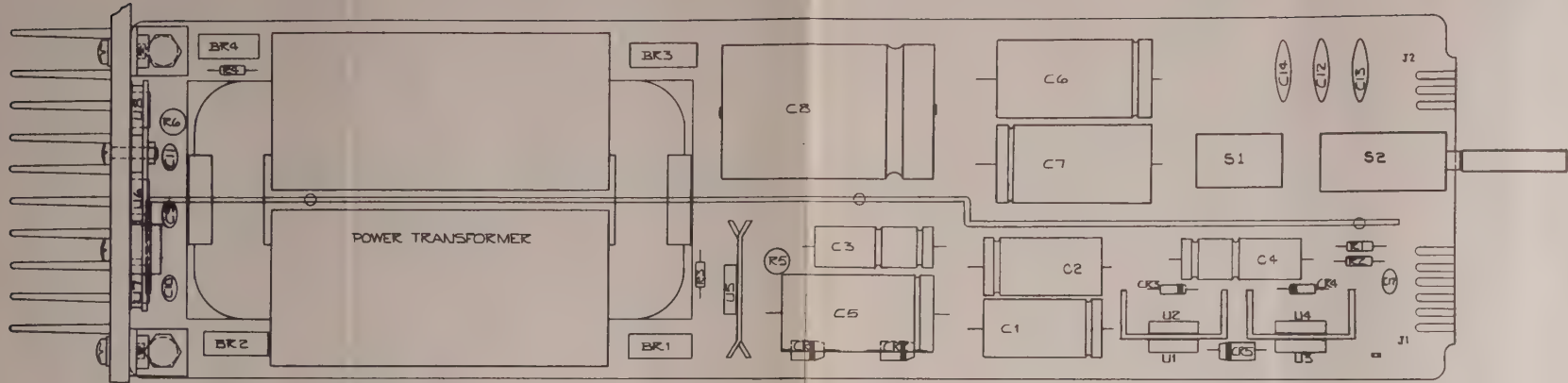
8500A/AE-1301

Figure 8-2: Interconnect Diagram Mother Assembly (cont)



MIS-1081

Figure 8-3. Bus Interconnect

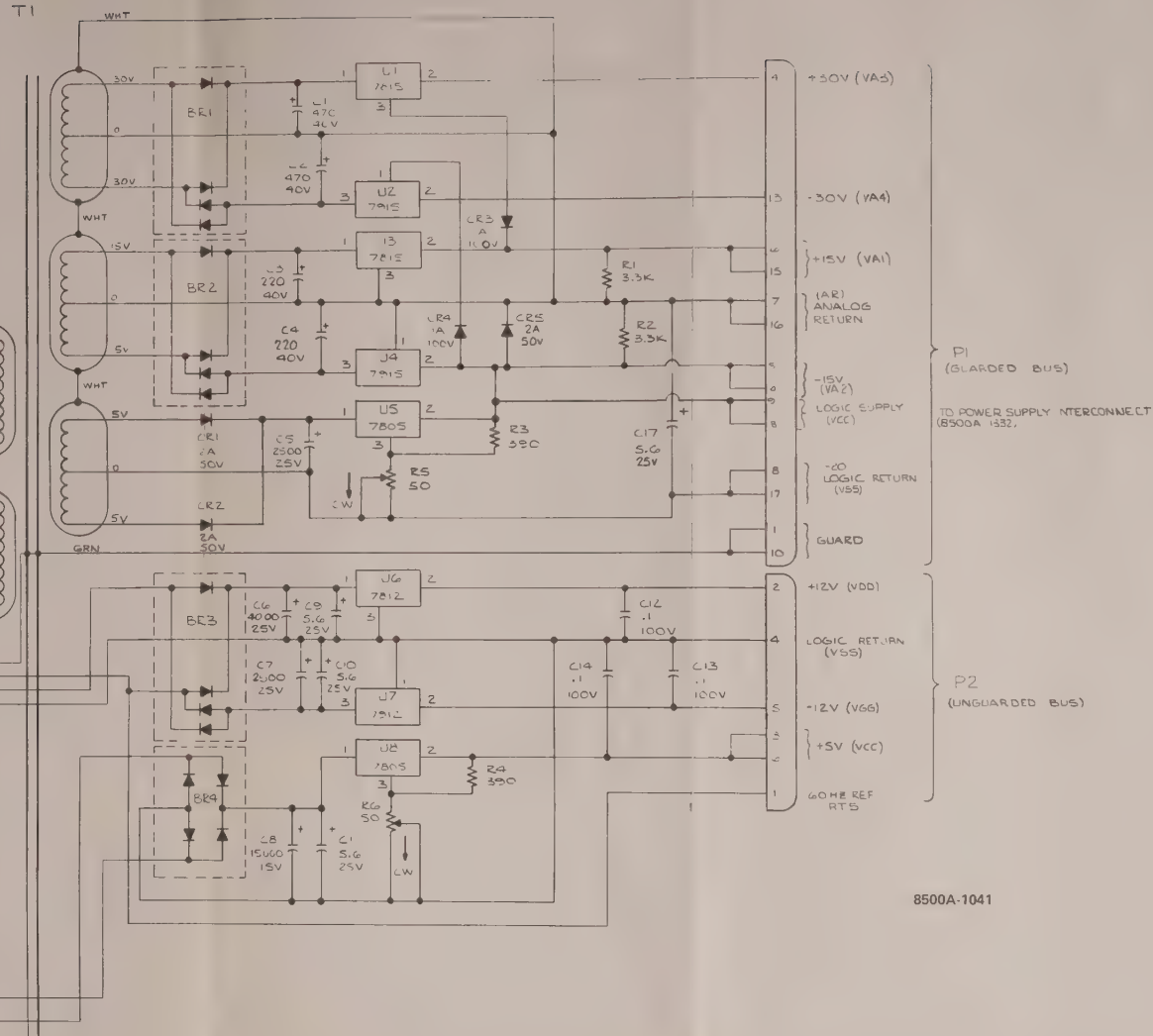
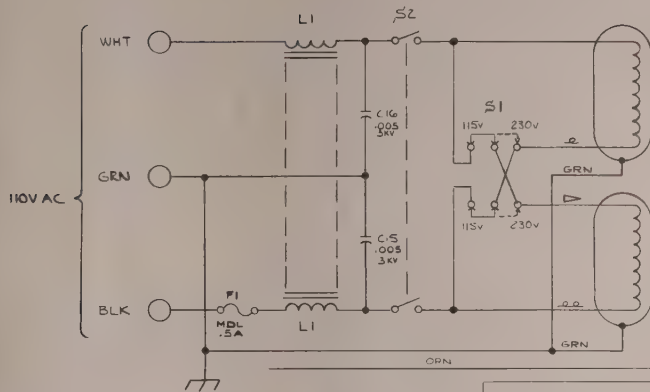


8500A-1641

Figure 8-4. A4 Power Supply PCB Assembly

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTANCE IN OHMS.
2. ALL RESISTORS C.C. $\frac{1}{4}W, 5\%$
3. ALL CAPACITANCE IN MICROFARADS
4. FOR ASSY DRG SEE 8500A-4041
5. FOR REF DES DRG SEE 8500A-1641
6. FOR PCB SEE 8500A-3041

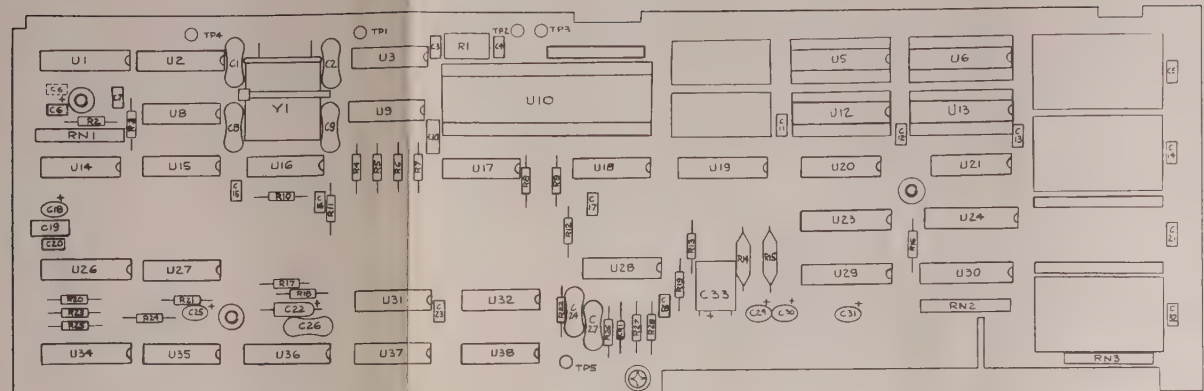


8500A-1041

Figure 8-4. A4 Power Supply PCB Assembly (cont)

NOTES:

1. FOR ASSEMBLY DWG. SEE MIS-4185.
2. FOR PCB SEE MIS-3185.
3. FOR SCHEMATIC SEE MIS-1185.



8500A-4185T

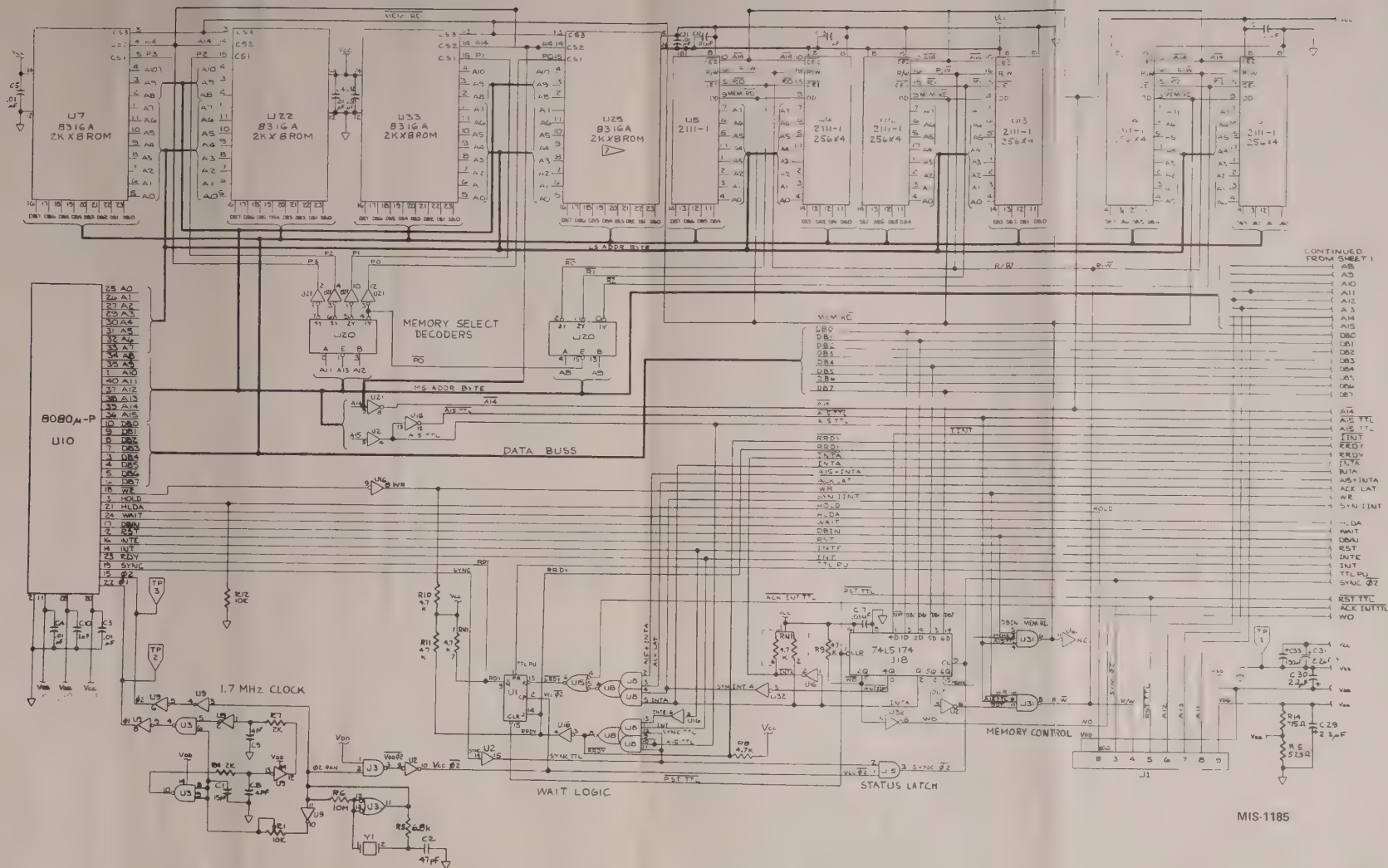
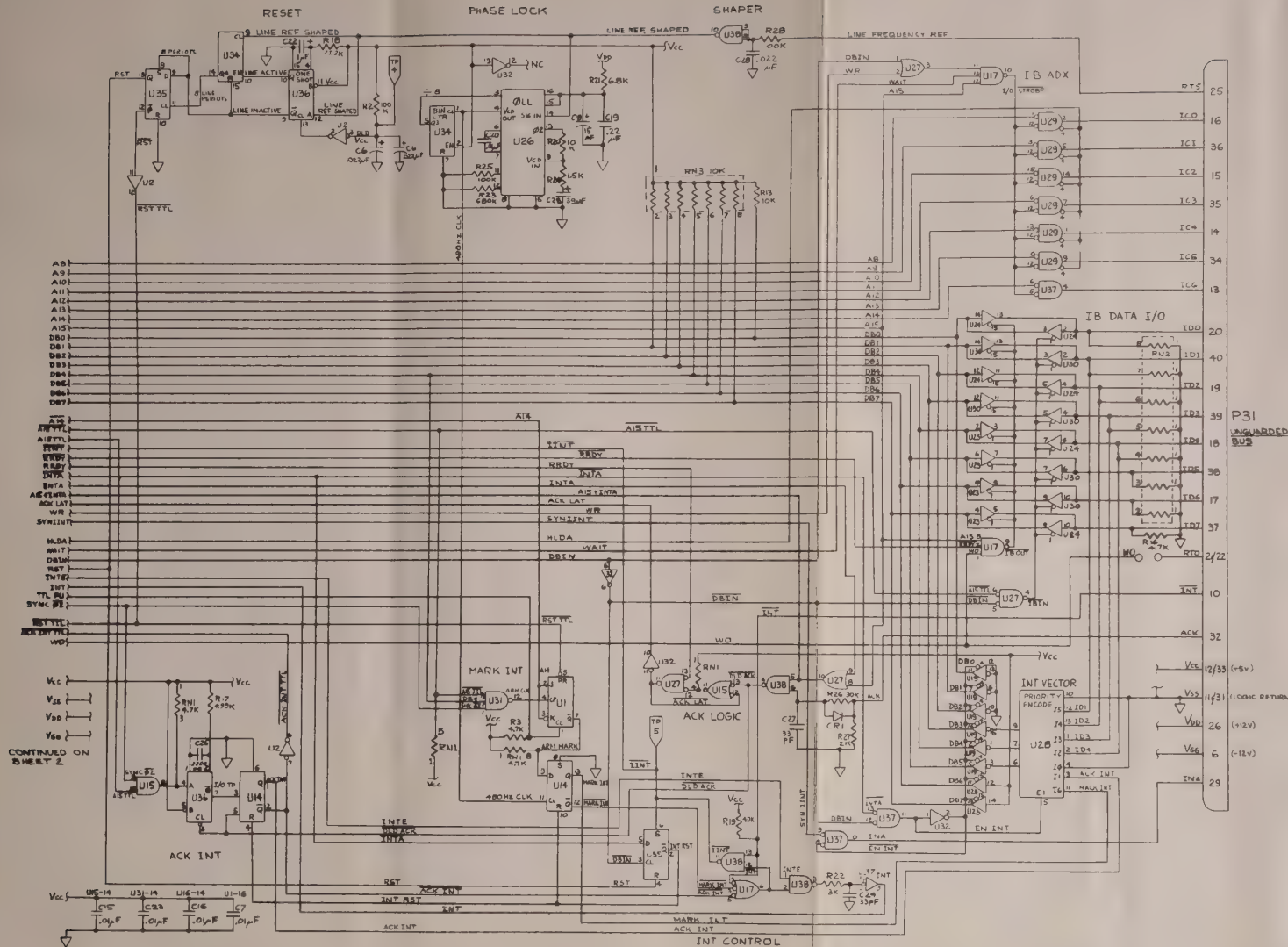


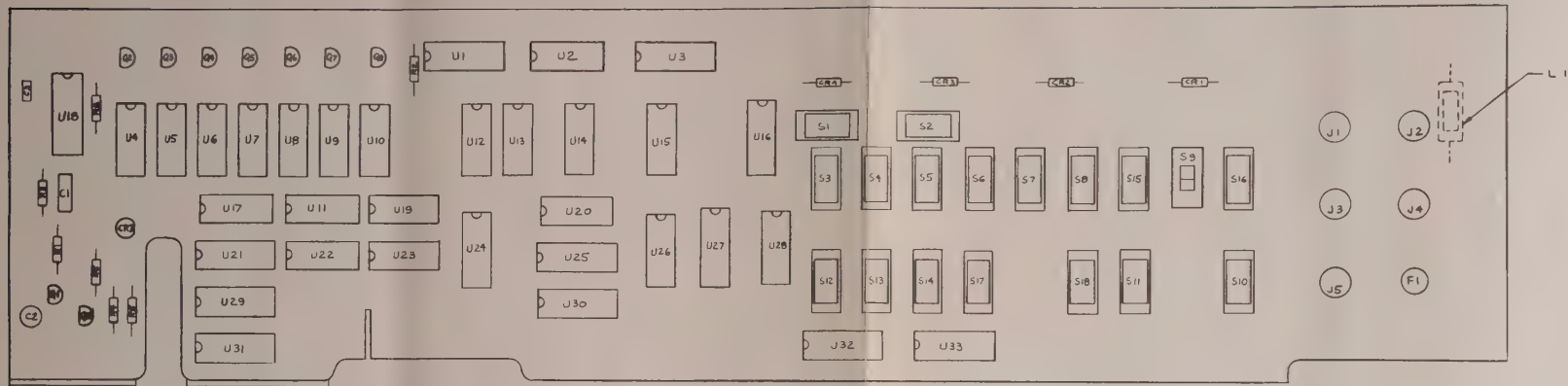
Figure 8-6. A6A1 Controller PCB Assembly (cont)

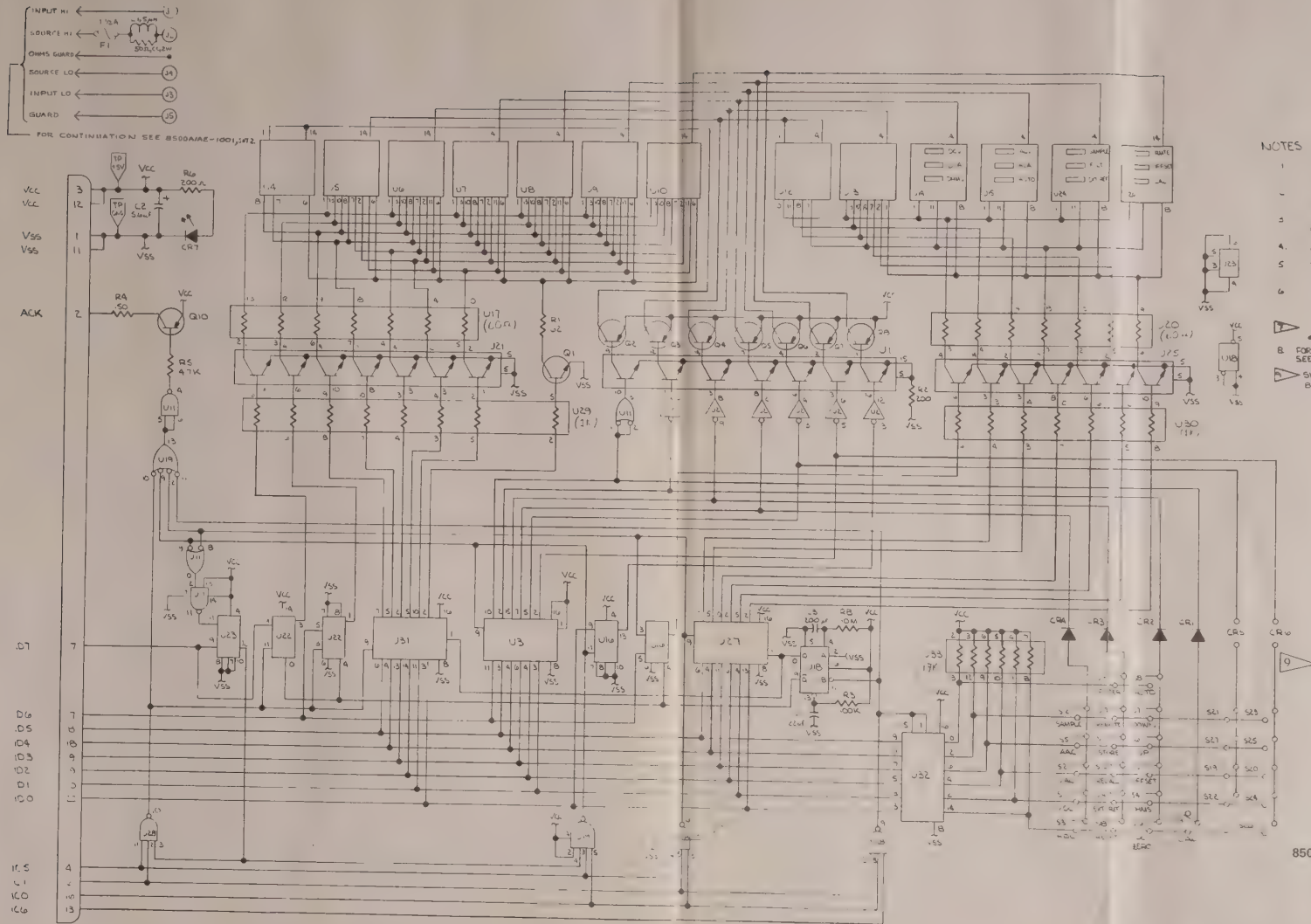


MIS-1185

Figure 8-6. A6A1 Controller PCB Assembly (cont)

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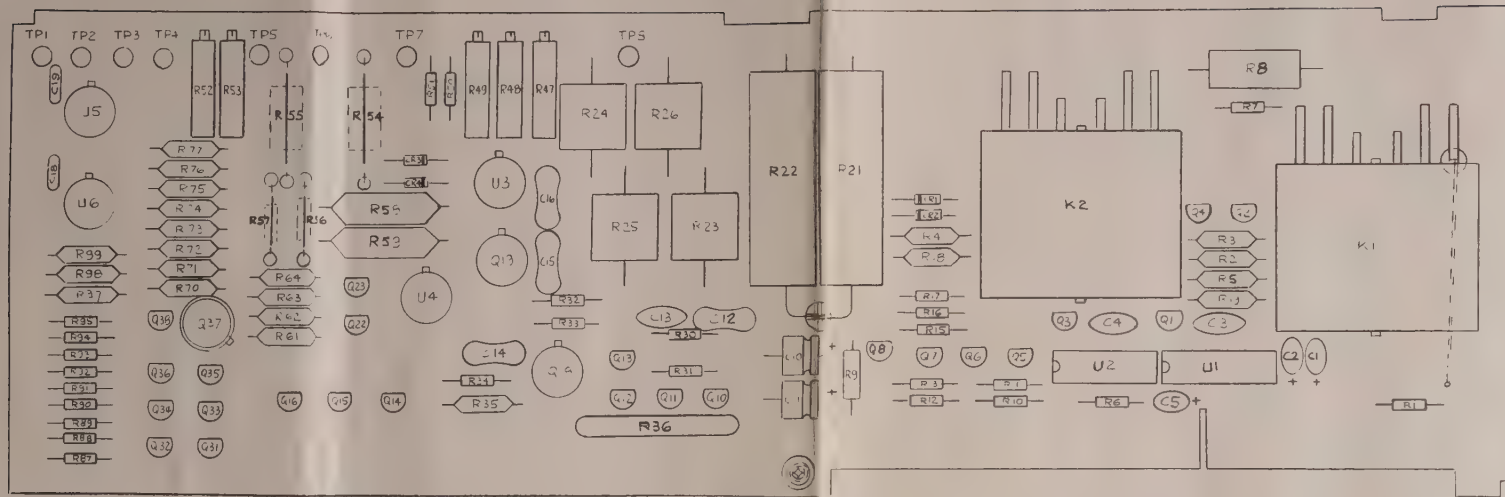


8500A/AE-1021

Figure 8-7. A7 Front Panel Display PCB Assembly (cont)

NOTE 5:

1. FOR SCHEMATIC DIAGRAM SEE M.I.S.-1100
2. FOR P.C.B. SEE M.I.S.-3100
3. FOR ASSY. DRG. SEE M.I.S.-4100
4. R54, R55, R56 & R57 WILL BE DETERMINED DURING TESTING. RESISTORS MAY BE INSTALLED.



MIS-1600

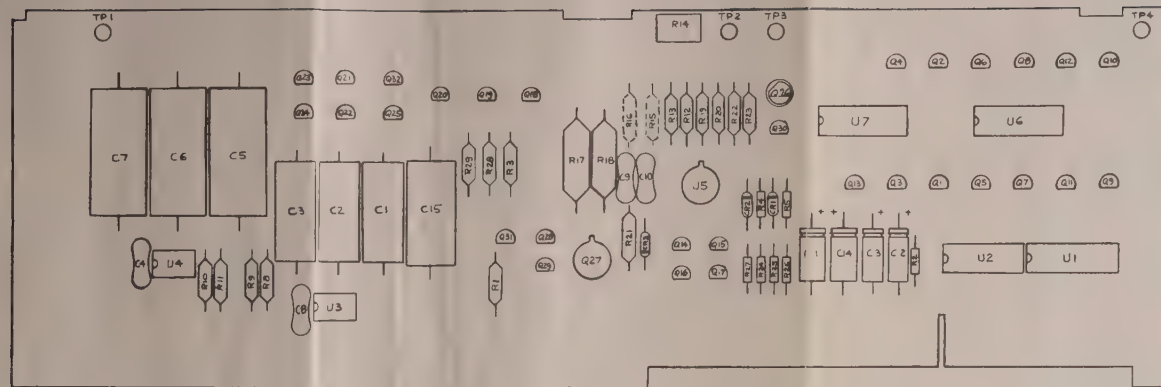
Figure 8-8. A8 DC Signal Conditioner PCB Assembly

Q0	Q1	Q2	Q3
5	20	15	20
5	20	20	15
5	20	15	10
20	15	20	5
20	15	15	15

INTERBUS INPUT (RT2)

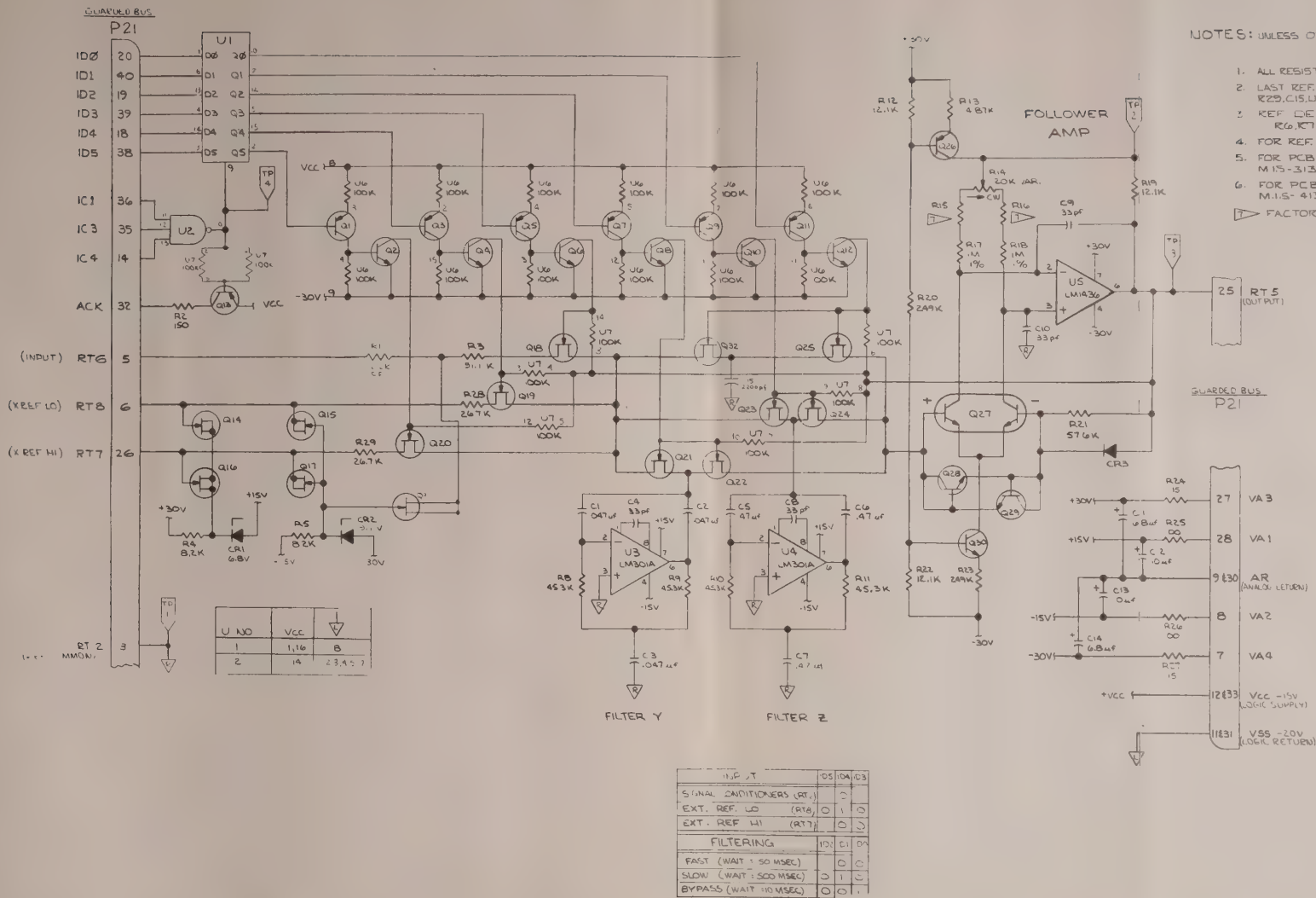


Figure 8-8. A8 DC Signal Conditioner PCB Assembly (cont)

NOTES:

1. FOR SCHEMATIC DIAGRAM SEE MIS-1130.
2. FOR PCB SEE MIS-3130.
3. FOR ASSEMBLY SEE MIS-4130.
4. R15 & R16 WILL BE SELECTED DURING TEST.

MIS-1730

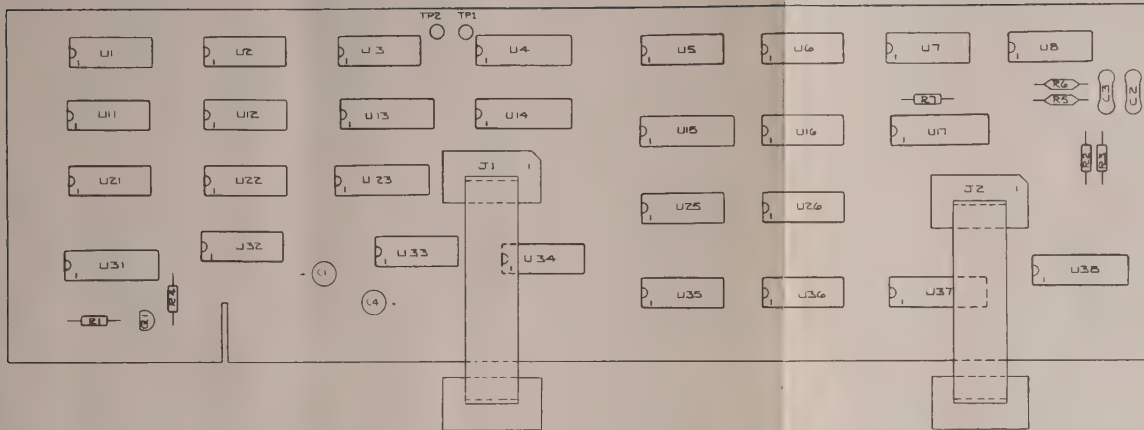


MIS-1130

Figure 8-9. A9 Active Filter PCB Assembly (cont)

NOTES:

1. FOR SCHEMATIC SEE M.I.S.-1141
2. FOR PCB DETAIL SEE M.I.S.-3141
3. FOR ASSY DRAWING SEE M.I.S.-4141



MIS-1741

Figure 8-10. A10A2 Fast RR A/D Converter Digital PCB Assembly

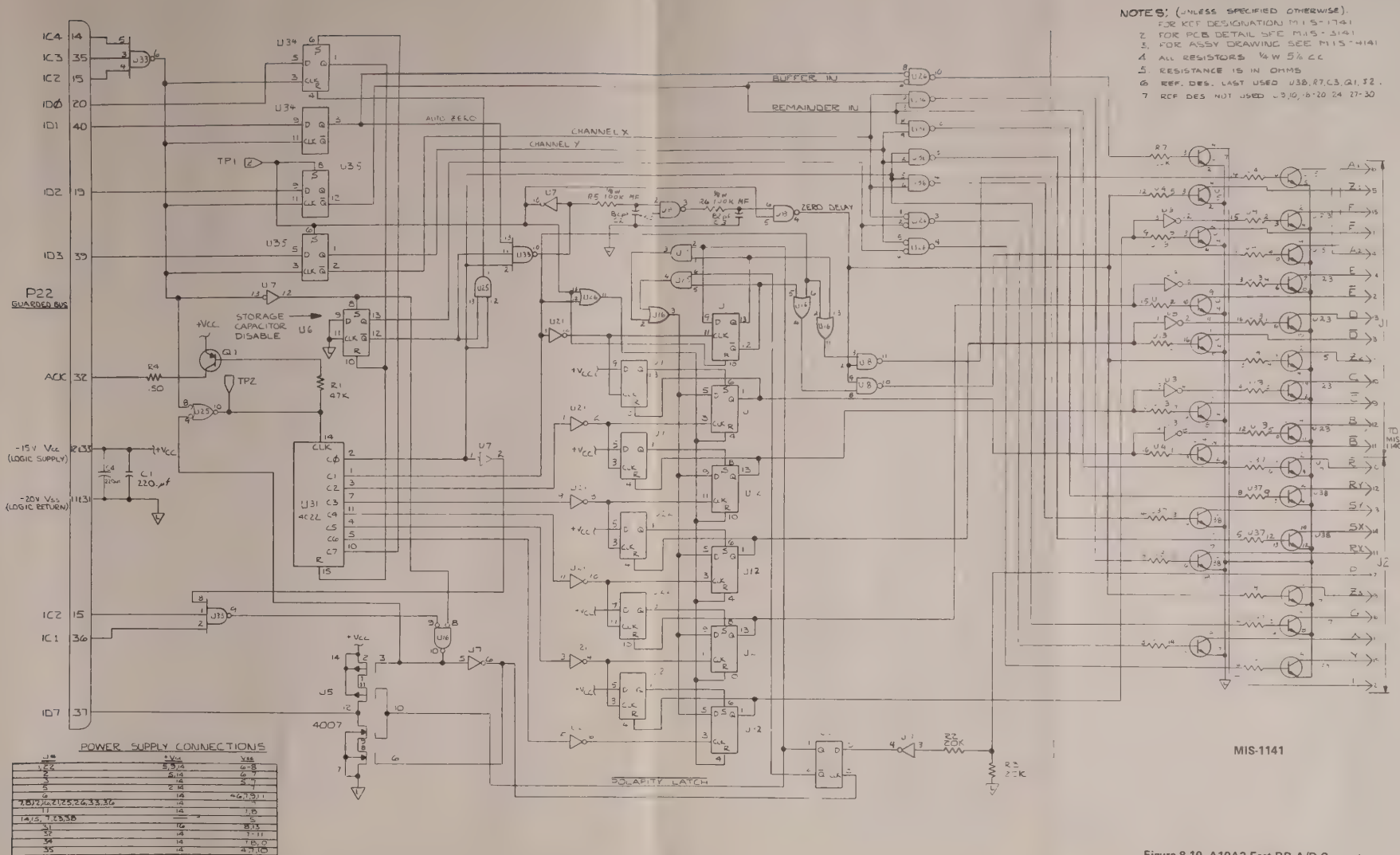
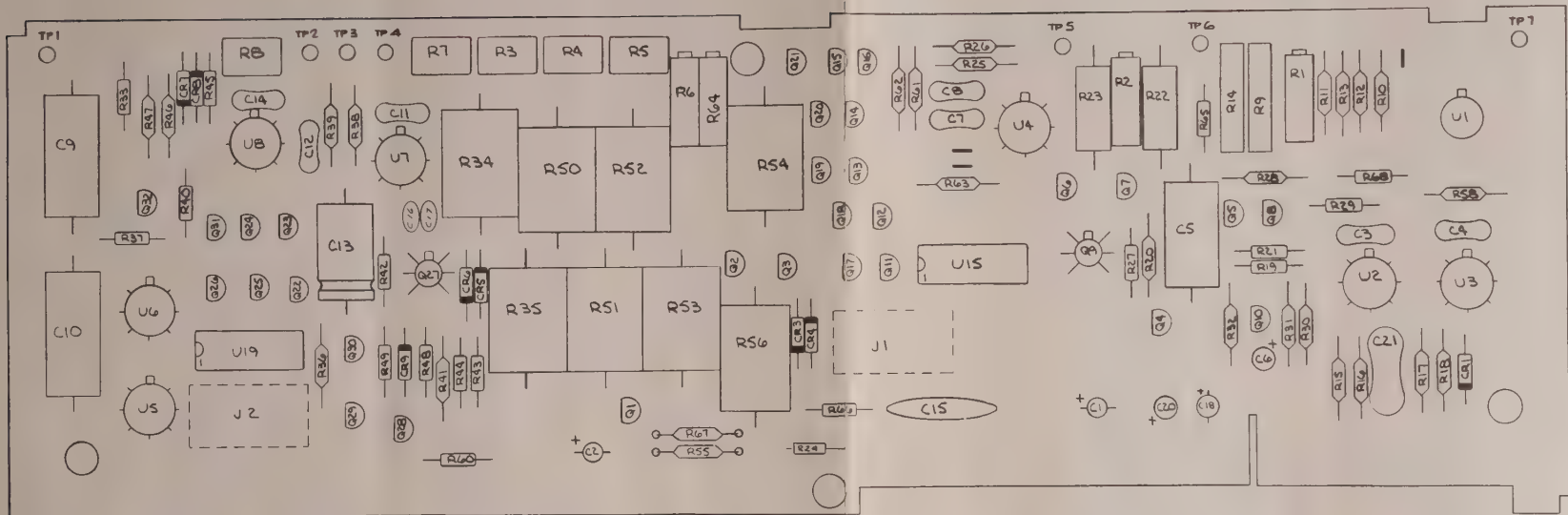


Figure 8-10. A10A2 Fast RR A/D Converter
Digital PCB Assembly (cont)

NOTES:

1. FOR SCHEMATIC DIAGRAM SEE M.I.S.-1140.
2. FOR P.C.B. SEE M.I.S.-3140.
4. FOR ASSEMBLY DRAWING SEE M.I.S.-4140.



MIS-1740

Figure 8-11. A10A1 A/D Analog PCB Assembly

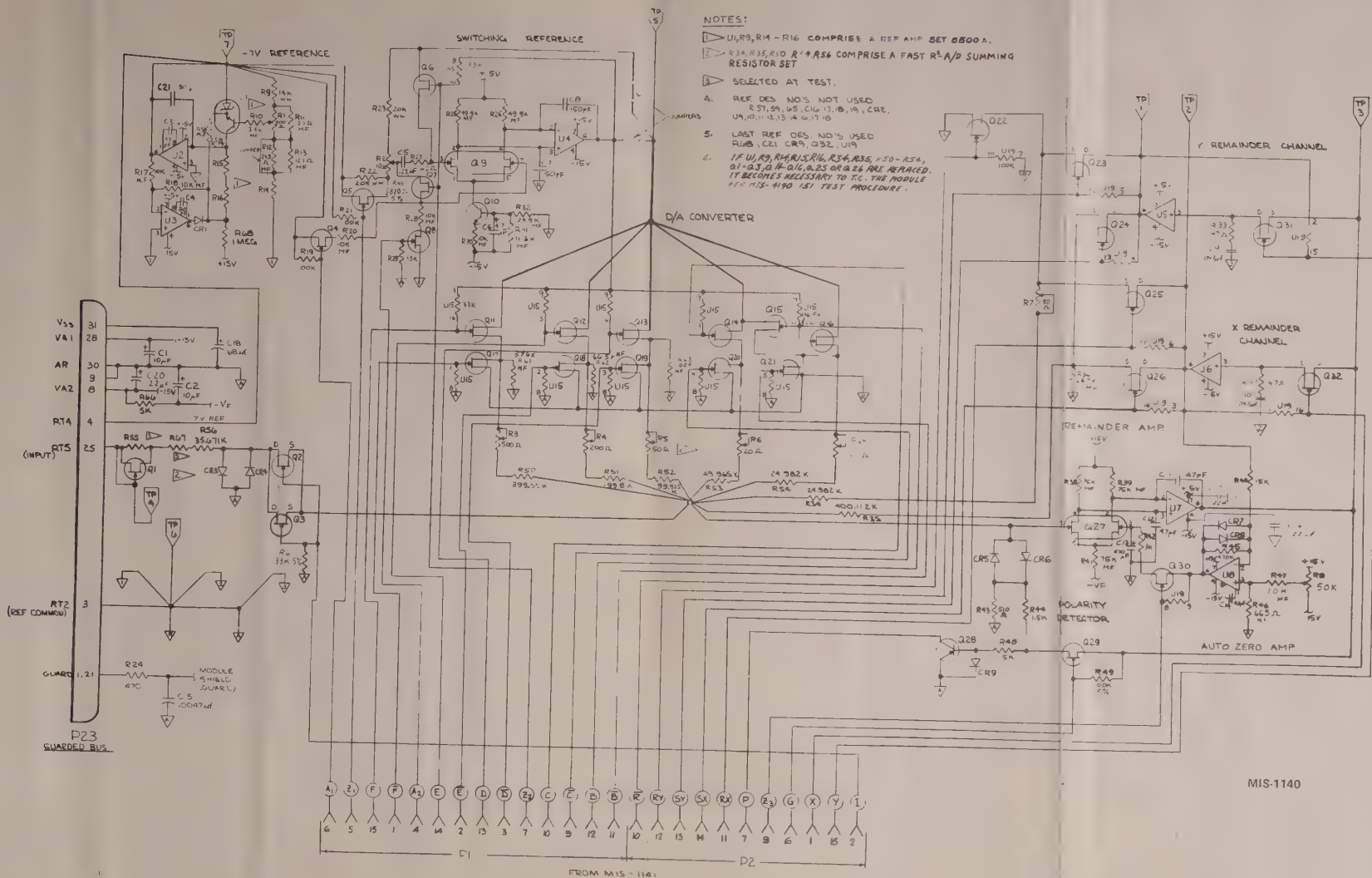


Figure 8-11. A10A1 A/D Analog PCB Assembly (cont)

Option —02 Ohms Converter

602-1. INTRODUCTION

602-2. Installation of the Ohms Converter provides precision resistance measurement capability ranging from 100 $\mu\Omega$ to 262 $M\Omega$. Both two-terminal and four-terminal measurements may be made.

602-3. SPECIFICATIONS

602-4. Table 602-1 lists the specifications of the Ohms Converter.

602-5. INSTALLATION

602-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing and removing modules. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

602-7. OPERATING NOTES

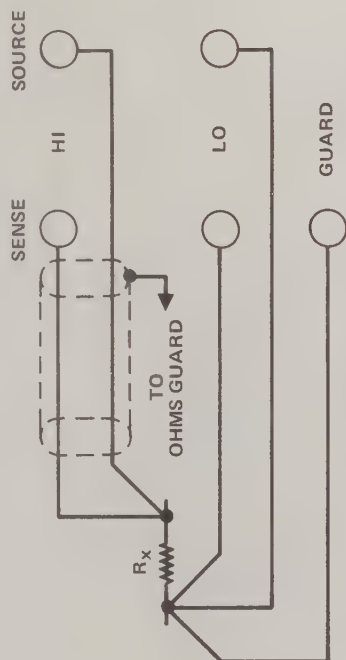
602-8. Operation of the front panel controls with the Ohms Converter Option installed is the same as described in Section 2 of this manual. Eight ranges are available for resistance measurements: 10, 100, 1K, 10K, 100K, 1M, 10M, and 100M. Ranges may be either manually or automatically selected. Four-wire measurements may be made up through the 100K range. In the 1M, 10M, and 100M ranges only two-wire measurements may be made, as lead resistance will not affect accuracy. However, the four-wire connections may still be used if desired. Sense HI to Source HI and Sense LO to Source LO connections must be made either with the shorting links provided (two-wire mode) or at the resistance to be measured (four-wire mode). Figure 602-1 shows possible connections for both the two-wire and four-wire modes.

Table 602-1. Ohms Converter Specifications

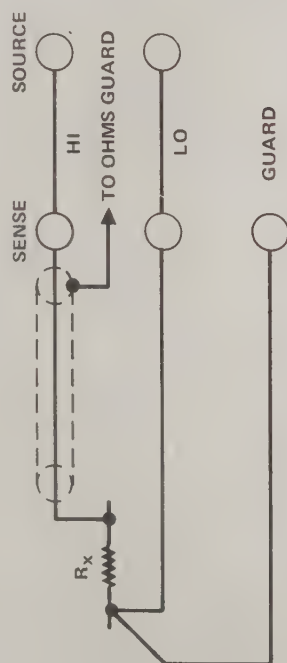
ACCURACY						
(Refer to the specifications table in section 1 for required environmental conditions)						
Range	NORMAL RESOLUTION Accuracy $\pm$ (% of Input + No. of Digits)			HIGH RESOLUTION Accuracy $\pm$ (% of Input + No. of Digits)		
	24 Hours	90 Days	1 Year	24 Hours	90 Days	1 Year
10 Ω	0.003 + 20	0.005 + 20	0.01 + 20	—	—	—
100 Ω	0.002 + 2	0.003 + 2	0.006 + 2	0.002 + 14	0.003 + 14	0.006 + 14
1 k Ω	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
10k Ω	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
100 k Ω	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
1 M Ω	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
10 M Ω	0.01 + 1	0.02 + 1	0.04 + 1	0.01 + 8	0.02 + 8	0.04 + 8
100 M Ω	0.03 + 1	0.05 + 1	0.1 + 1	0.03 + 8	0.05 + 8	0.1 + 8

Table 602-1. Ohms Converter Specifications (Continued)

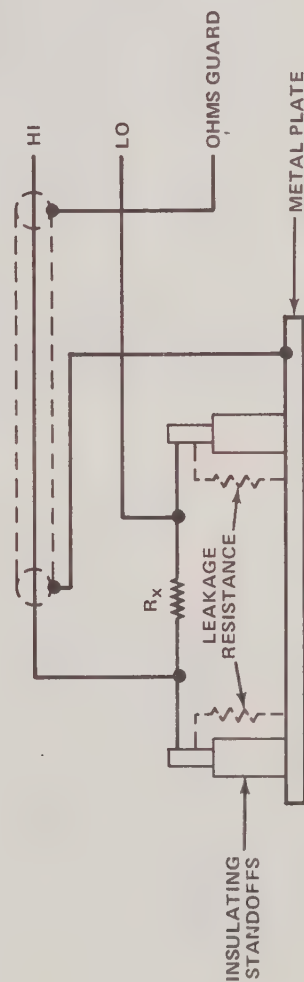
OPERATING CHARACTERISTICS						
Range	Full Scale	Current Through Unknown	Normal Resolution		High Resolution	
			Resolution	Temperature Coefficient* ± (ppm/rdg + No. of Digits)/°C	Resolution	Temperature Coefficient* ± (ppm/rdg + No. of Digits)/°C
10Ω	31.25Ω	10 mA	100 uΩ	8 + 1.5	—	—
100Ω	250Ω	10 mA	1 mΩ	7 + 0.2	100 uΩ	7 + 2
1 kΩ	2 kΩ	1.25 mA	10 mΩ	7 + 0.2	1 mΩ	7 + 2
10 kΩ	32 kΩ	78 uA	100 mΩ	7 + 0.2	10 mΩ	7 + 2
100 kΩ	256 kΩ	9.8 uA	1Ω	7 + 0.2	100 mΩ	7 + 2
1 MΩ	4.096 MΩ	4.9 uA	10Ω	7 + 0.2	1Ω	7 + 2
10 MΩ	32.768 MΩ	0.61 uA	100Ω	30 + 0.2	10Ω	30 + 2
100 MΩ	262.144 MΩ	76 nA	1 kΩ	50 + 0.2	100Ω	50 + 2
*0°C to 18°C and 28°C to 50°C						
MAXIMUM LEAD RESISTANCE						
Mode	Leads	Range	Maximum Lead Resistance			
4-wire	Source	10 – 100Ω	10Ω			
4-wire	Source	1 kΩ	100Ω			
4-wire	Source	10 kΩ – 100 MΩ	1 kΩ			
4-wire	Source	All	1 kΩ			
2-wire	Source	All	Less than 0.001% of range unless offset			
OPEN CIRCUIT VOLTAGE			OVERLOAD			
Range	Voltage	Configuration	± 400V dc to 60 Hz, or 560 volts peak ac above 60 Hz maximum continuous on any range with no damage.			
10Ω to 100 kΩ 1 MΩ to 100 MΩ	7 volts max 25 volts max	4 Terminal 2 Terminal	SETTLING TIME – (To Rated Accuracy)			
			80 ms, Fast Filter 800 ms, Slow Filter			
DIGITIZING TIME						
Mode of Operation	Filter	60 Hz		50 Hz		
		Approx. Rdg. Rate	Digitizing Time	Approx. Rdg. Rate	Digitizing Time	
Bench	Fast	4 rdg/s	250 ms	3-1/3 rdg/s	300 ms	
	Fast	1-1/2 rdg/s	700 ms	1-1/4 rdg/s	800 ms	
	Slow	1-1/4 rdg/s	800 ms	1 rdg	1000 ms	
	Slow	5/6 rdg	1200 ms	3/4 rdg	1450 ms	
Remote	Fast	4 samples/rdg	145 ms	4 samples/rdg	175 ms	
	Slow	4 samples/rdg	700 ms	4 samples/rdg	840 ms	
(Subtract for fast Ohms)	Fast	—	110 ms	—	—	
	Slow	—	560 ms	—	—	



FOUR TERMINAL OHMS MEASUREMENT CONNECTIONS TO MAXIMIZE THE EFFECTIVENESS OF THE GUARDS



TWO TERMINAL OHMS MEASUREMENT CONNECTIONS TO MAXIMIZE THE EFFECTIVENESS OF THE GUARDS



OHMS GUARD IS AVAILABLE ONLY THROUGH THE OPTIONAL REAR INPUT (-17) CONNECTOR

Figure 602-1. Ohms Measurement Connections And Guarding

602-9. For the two-wire ohms mode, the instrument should be zeroed with a good quality short between Sense-Source HI and Sense-Source LO. Select either autoranging or the 10 Ω range manually. Depress the STORE switch. Depress the V DC/ Ω ZERO switch. All ranges are now automatically zeroed. Ohms zero cannot be recalled. Depressing the RECALL switch while in Ohms results in a display of ERROR 0, then a return to the program. To compensate for lead resistance use the Offset mode. Short the ends of the leads together. Depress the STORE switch, then the OFFSET switch. This enters the lead resistance value into memory. Depress the OFFSET switch again (OFFSET LED illuminated) to enter the Offset mode in which the value of lead resistance will automatically be subtracted from further readings.

602-10. In the four-wire ohms mode, the instrument should be zeroed by placing a good quality short at the ends of the leads. Depress the V DC/ Ω ZERO switch to enter the zero value, which will automatically be subtracted from further readings.

602-11. Guarding

602-12. The ohms guard connection is available only through the optional Rear Input Connection (-17). Figure 602-1 shows optimal use of the guard. Basically the ohms guard is used to minimize leakage resistance between the HI and LO leads which would appear as shunt resistance across high R_x values. In some high-resistance measurement set-ups, leakage resistance in or on the surface of insulating materials may provide enough shunt resistance to degrade the accuracy of the measurement. Figure 602-1 illustrates one such case. Connecting the ohms guard to the metal plate on which the standoffs are mounted reduces the effect of leakage resistance through or on the standoffs.

602-13. THEORY OF OPERATION

602-14. The function of the Ohms Converter is to produce a current through an unknown resistance such that the voltage across the unknown is proportional to the value of resistance. This is accomplished by configuring the unknown resistance, R_x , as the feedback element of an operational amplifier. A reference voltage, V_{REF} , is applied through a reference resistor, R_{REF} , to the summing node of the amplifier. By definition of an ideal operational amplifier, the current through R_x is the same current flowing through R_{REF} (the summing node represents a virtual ground). Figure 602-2 is a simplified schematic of the Ohms Converter and contains an illustration of the derivation of the formula for R_x . The current flowing through R_{REF} equals

$(V_1 - V_2)/R_{REF}$. Using the expression for current to obtain the value of R_x :

$$R_x = R_{REF} \left(\frac{V_o}{V_1 - V_2} \right).$$

The Ohms Converter multiplexes the voltages which, after being routed through the DC Signal Conditioner and the Filter module, are measured by the A/D Converter.

602-15. The current reference for the Ohms Converter is derived from the -7V reference (RT4) from the A/D Converter. U4 is an inverting amplifier with two possible feedback paths to produce either approximately +2.3V or +18.5V as V_1 . U4 drives Q8 with Q8 serving as a larger current source than is available from U4. R41, R45, and R56 are the reference resistors, each having an adjustment.

602-16. R_x is the feedback element for the operational amplifier composed of Q9 and U5. U5 drives Q37 which serves as a higher current source. This arrangement also allows a larger output voltage swing. Note that Q9 and U5 are configured as an inverter, yet the output of U5 is a positive voltage. Q37 draws its emitter current through R48 and R49 from the -30V supply with CR18 and CR13 ensuring that Q37 need not be in a state of saturation. SOURCE voltages out are negative voltages at SOURCE LO with respect to circuit common. In the 100M range, the voltage applied to R41 is divided by 8. However, the unattenuated V_{REF} is measured. The factor of 8 is preserved by assigning R_{REF} the value of $8 \times R41$ (32.768 M Ω) in the equation. As the Ohms Converter downranges, R41 remains enabled so lower R_{REF} values are actually parallel combinations. V_2 is not measured in the three highest ranges (1M, 10M, 100M) since lead resistance will not be large enough to affect accuracy.

602-17. Extensive overvoltage protection has been provided for the Ohms Converter. Refer to the full schematic. Voltages appearing on the SENSE or SOURCE HI terminals in excess of +28V or -3V (with respect to circuit common) are clamped to ground by Q14, CR7, Q10, and Q39. U5 is configured as a voltage comparator biased by CR19 and R14. The clamping action of Q14 or Q10 causes a voltage on the input Lo line which triggers comparator U5 through Q11 or Q15. In either case the output at U5 pin 7 toggles to its maximum positive level, clocking U3 while placing a high on the ID3 line. This opens relay K1 and removes the input voltages from the module. The high from U5 also inhibits the ACK logic so an Error 4 will be displayed. CR13 and CR14 at the output of Q9, U5 are high voltage blocking diodes. E1 is a spark gap preventing voltages in excess of 400V between the guard shield and circuit common.

602-18. The Ohms Converter is addressed by IC1, 2, 3 high, and must be addressed for each sample voltage. Samples are multiplexed out at the rate of one every four msec. This requires the fastest response time in the DC Signal Conditioner of any measurement mode.

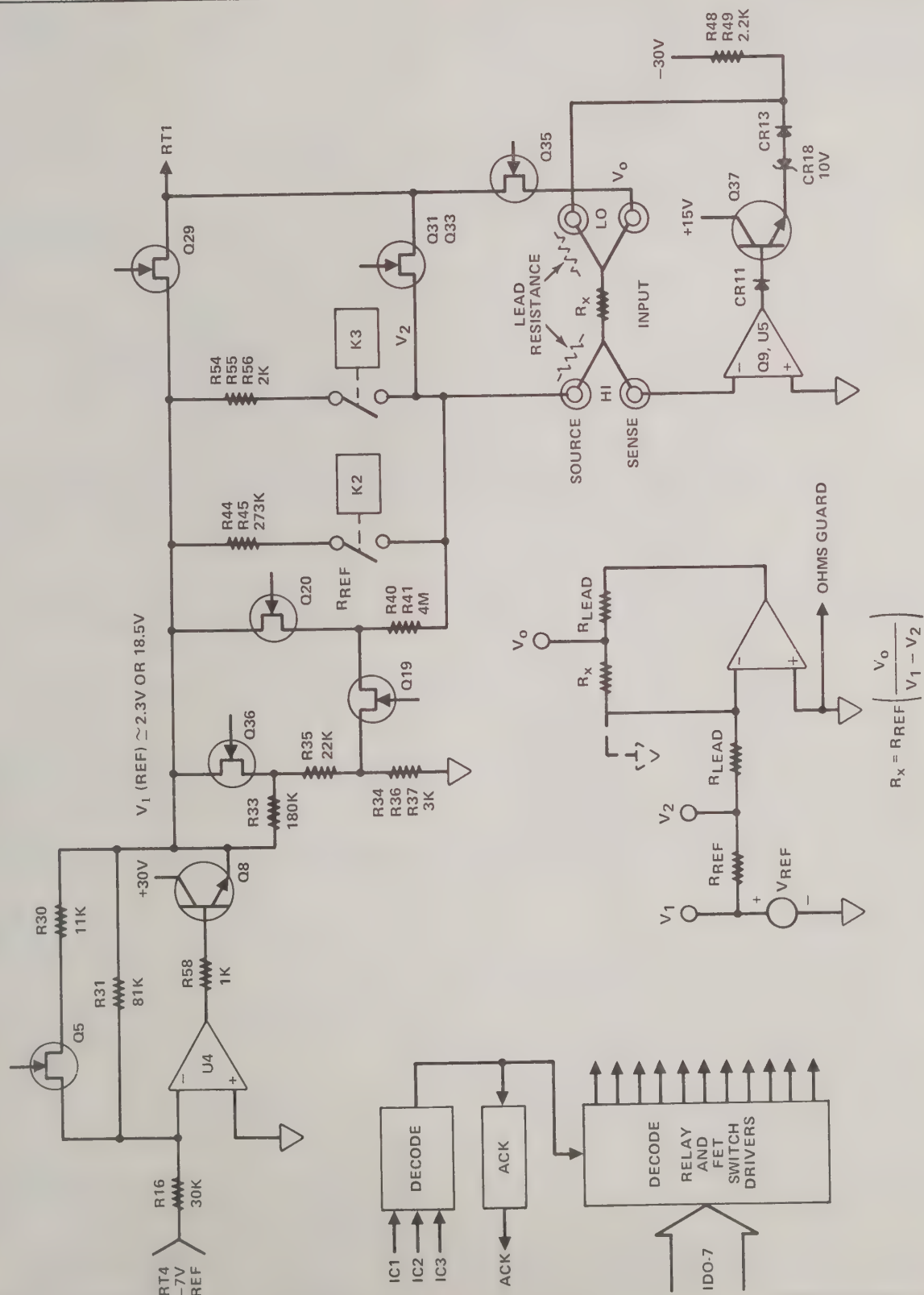


Figure 602-2. Ohms Converter

602-19. MAINTENANCE**602-20. Performance Test**

602-21. Test the Ohms function using the following procedure:

1. Connect test leads to the instrument in the four-wire configuration.
2. Select the Ohms function and Autoranging.
3. Short the HI and LO Ω SOURCE leads, short the HI and LO SENSE leads; then connect the two pairs of shorted leads together.
4. Zero the instrument by depressing the STORE switch, then the V DC/ Ω ZERO switch.
5. Remove the shorts and sequentially connect the standard resistors in Table 602-2. The 8500A readings should fall within the limits specified.

Table 602-2. Performance Test

Standard Resistor	8500A Reading	
	Low (exponent)	High (exponent)
10	9.9975	10.0025
100	99.995	100.005
1K	.99996 (+3)	1.00004 (+3)
10K	9.9996 (+3)	10.0004 (+3)
100K	99.996 (+3)	100.004 (+3)
1M	.99996 (+6)	1.00004 (+6)
10M	9.9979 (+6)	10.0021 (+6)
100M	99.949 (+6)	100.051 (+6)

602-22. Calibration

602-23. Use the following procedure to calibrate the Ohms Converter:

1. Remove power and remove the Calibration Memory if installed.
2. Reapply power and allow a two hour warm-up.
3. Ensure that the dc Volts accuracy is within tolerance.
4. Short the HI and LO AMPS/ Ω SOURCE terminals, short the HI, LO and GUARD VOLTS/ Ω SENSE terminals, then short the two HI terminals. Use the terminal shorting links provided with the instrument and/or equivalents.

5. Use manual range selection to prevent range changes while testing at the range extremities.
6. Select the 10 Ω range on the DMM.
7. Adjust R24 for a reading between -0.0003 and +0.0003.
8. Step through the other seven ranges, checking that the reading is 0 ± 1 digit on all seven ranges.
9. Remove the shorting links and make four-wire ohms measurement connections to the INPUT terminals. Select the 1M Ω range and connect the input leads to a 4 M Ω standard resistor.

NOTE

Refer to Table 4-1 of the Instruction Manual for specifications on the Standard Resistors.

10. Adjust R40 for a reading between 3.99998 (+6) and 4.00002 (+6).
11. Select the 100 M Ω range and connect the input leads to a 100 M Ω standard resistor.
12. Adjust R37 for a reading between 99.995 (+6) and 100.005 (+6).
13. Select the 100 k Ω range and connect the input leads to a 250 k Ω standard resistor.
14. Adjust R44 for a reading between 249.998 (+3) and 250.002 (+3).
15. Select the 1 k Ω range and connect the input leads to a 1.9 k Ω standard resistor.
16. Adjust R54 for a reading between 1.89998 (+3) and 1.90002 (+3).
17. Select the 10 Ω range and short the four-terminal leads for a zero input.
18. Perform the Ohms Zero procedure found in the operating instructions, ensuring the result is 0.0000 ± 1 digit.
19. Perform the tests in Table 602-3. There are no adjustments for the readings, if any reading exceeds the listed tolerance the module is not acceptable.

Table 602-3. Calibration Tests

Resistance Standard	Readings		
	Minimum	Nominal	Maximum
10	9.9989	10.0000	10.0011
100	99.997	100.000	100.003
1k	0.99997 (+3)	1.00000 (+3)	1.00003 (+3)
10k	9.9997 (+3)	10.0000 (+3)	10.0003 (+3)
100k	99.997 (+3)	100.000 (+3)	100.003 (+3)
1M	0.99997 (+6)	1.00000 (+6)	1.00003 (+6)
10M	9.9989 (+6)	10.0000 (+6)	10.0011 (+6)
100M	99.969 (+6)	100.000 (+6)	100.031 (+6)

602-24. TROUBLESHOOTING

602-25. Troubleshooting procedures for the Ohms Converter follow the format used for the mainframe instru-

ment. Table 602-4, Failure Isolation, assures that the problem is in the Ohms Converter. Table 602-5 lists symptoms and possible failures in the order of probability. Figure 602-3 shows timing relationships, while Tables 602-6 through 602-8 give additional troubleshooting information.

602-26. Always remove power before removing or installing modules. RT1 is available only in the front four option slots and not in the Isolator or Interconnect slot.

602-27. PARTS LIST

602-28. Table 602-9 is a parts breakdown for the Ohms Converter. Refer to Section 5 of this manual for ordering and use code information.

Table 602-4. Failure Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Perform DC Volts test (Section 4). Is DC Volts within tolerance?	2	Section 4
2	Perform Ohms test. Is Ohms within tolerance?	4	3
3	Remove all optional modules except Isolator and Ohms converter.		
4	Is Ohms now within tolerance?	5	6
5	An optional module is affecting Ohms. Replace one at a time until Ohms goes bad. Last one in is faulty — go to appropriate portion of Section 6.		
6	Is Isolator installed?	7	9
7	Remove Isolator. Insert Jumper/Monitor pcb. Is Ohms within tolerance?	8	9
8	Bad Isolator. Go to Subsection 608.		
9	Check power supply voltages as follows. Test DMM LO on AR (analog return). VA1 = +14.25 to 15.75V VA2 = -14.25 to -15.75V VA3 = +29 to 32V VA4 = -29 to -32V Vcc = -15V } Difference = 4.9 Vss = -20V } to 5.2 RT4 = -6.993 to -7.007		
10	Are the supply voltages within tolerance?	11	Section 4
11	The problem is probably in the Ohms board. However, the DC Signal Conditioner may contribute errors if the slew rates of the amplifiers are not fast enough. Go to Table 602-5.		

Table 602-5. Symptom Analysis

SYMPTOM	POSSIBLE FAILURE
No Ohms Readings (V_0) (V_1)	U5, Q9, Q35, Digital Logic U4, Q8, Q29 Digital Logic & Drivers
Ohms Zero Drift	U5, Q9
10K — 100K Ranges Bad	Q32, Q33, Digital
10 — 100 — 1K Ranges Bad	Q30, Q31, Digital
10M Full Scale Low	Q20, Q22
No ACK	U5, Q14, Q11, Q38
All Ranges Out of Tolerance	Q37, U5
100M Noisy, 30M High	Q10, K3 Shorted
1K, 100K, 10M, 100M Ranges Bad	Q5, Q4
100M Range Bad	Q20, Q22, Q19 Leaky
Display Error 4 with no voltage at input	Q14
Noisy at 30M or Full Scale	CR15, CR17, CR4, CR8
Full Scale 1M, 10M, 100M Ranges Out of Tolerance	CR18
DC SIGNAL CONDITIONER	
Slew Rates Bad	Q37, Q38, Q19, U3, U5, U6

Note: If Q9, Q19, U5, R19, R20, R21, R23, R25, or R26 are replaced it is necessary to return the module to the factory (Attn: Parts) for temperature compensation.

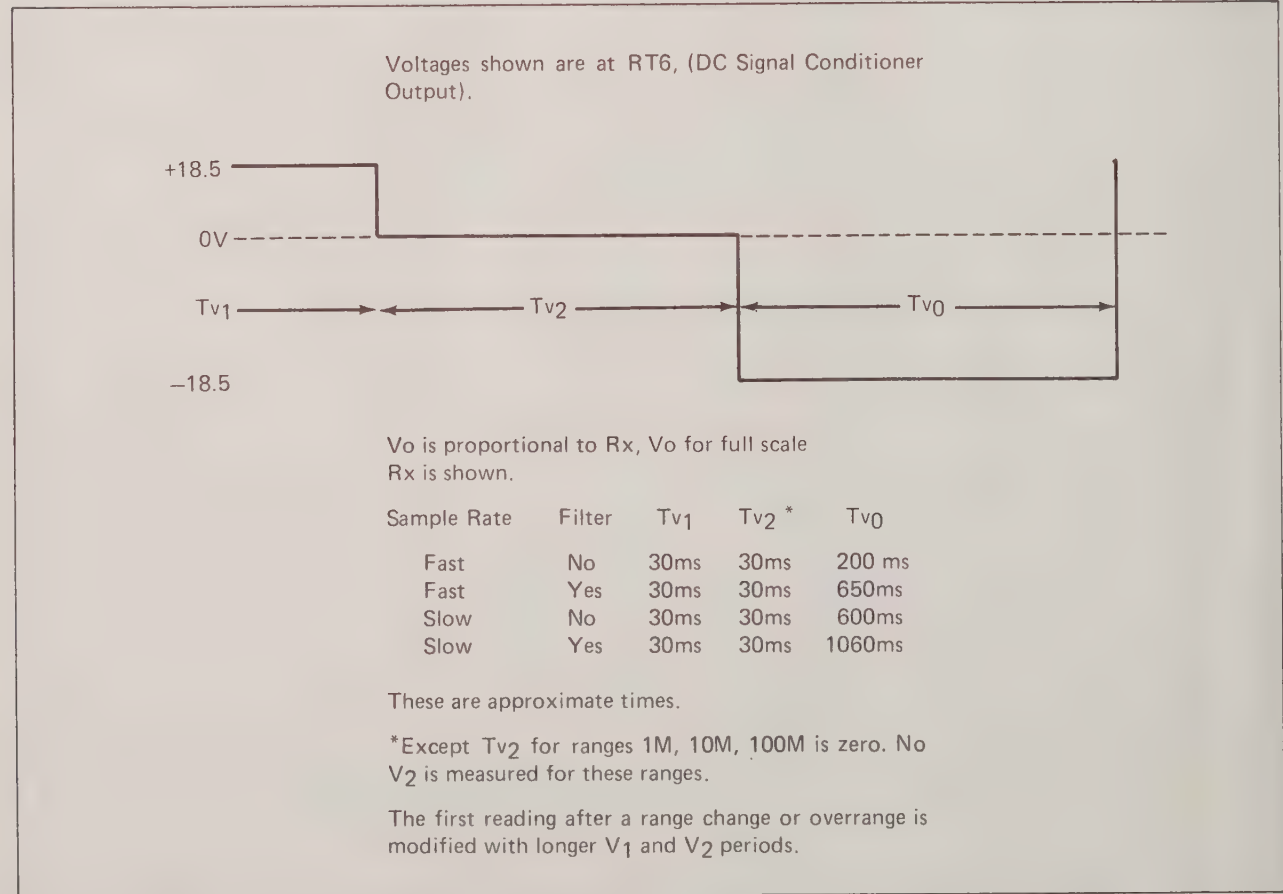


Figure 602-3. Timing

Table 602-6. Voltage Measurements

Range	Full Scale	V* TP2	R ref	I ref* (Source HI)	V ₀ * (Range Value)	V ₁ * (TP2)	V ₂ (Offset)
10	31.25	+18.5V	2K	9.3ma	.093V	+18.5	< 100mv
100	250	+18.5V	2K	9.3ma	.93V	+18.5	< 100mv
1000	2000	+2.3V	2K	1.2ma	1.2V	+2.3	< 100mv
10K	32K	+18.5V	256K	72μa	.72V	+18.5	< 100mv
100K	256K	+2.3V	256K	9μa	.9V	+2.3	< 100mv
1M	4.091M	+18.5V	4.091M	4.5μa	4.5V	+18.5	NA
10M	32.728M	+2.3V	4.091M	.56μa	5.6V	+2.3	NA
100M	261.824M	+2.3V/8	4.091M	70na	7V	+2.3	NA
* Approximate values (± 5%) TP1 is always -7.0V TP3 Ref common (use for low side of measurements) TP4 amplifier offset (<10μV properly adjusted) V ₀ is proportional to RX V ₂ will vary some with range change							
SCANNER: Voltages will appear on RT1 in order. V ₀ - V ₁ - V ₂							

Table 602-7. Range Switch Closures

0 = Switch Open 1 = Switch Closed							Chart applies for time the particular voltage is SCANNED. All other times "0" applies.			
	K1	K2	K3	Q5	Q19	Q20	V ₀ Q29	V _{2a} Q31	V _{2b} Q33	V ₁ Q35
10Ω	1	0	1	0	0	1	1	1	0	1
100Ω	1	0	1	0	0	1	1	1	0	1
1KΩ	1	0	1	1	0	1	1	1	0	1
10KΩ	1	1	0	0	0	1	1	0	1	1
100KΩ	1	1	0	1	0	1	1	0	1	1
1MΩ	1	0	0	0	0	1	1	0	0	1
10MΩ	1	0	0	1	0	1	1	0	0	1
100MΩ	1	0	0	1	1	0	1	0	0	1
OHMS	0	0	0	1	0	1	0	0	0	0

Table 602-8. Address and Data Coding

ADDRESS IC1, 2, 3 HIGH									
Range	V	ID ϕ	ID1	ID2	ID3	ID4	ID5	ID6	ID7
10	V ϕ	0	1	1	0	0	1	1	0
	V ₁	1	0	1	0	0	1	1	0
	V ₂	1	1	0	0	0	1	1	0
100	V ϕ	0	1	1	0	0	1	1	0
	V ₁	1	0	1	0	0	1	1	0
	V ₂	1	1	0	0	0	1	1	0
1K	V ϕ	0	1	1	0	1	1	1	0
	V ₁	1	0	1	0	1	1	1	0
	V ₂	1	1	0	0	1	1	1	0
10K	V ϕ	0	1	1	0	0	0	1	1
	V ₁	1	0	1	0	0	0	1	1
	V ₂	1	1	0	0	0	0	1	1
100K	V ϕ	0	1	1	0	1	0	1	1
	V ₁	1	0	1	0	1	0	1	1
	V ₂	1	1	0	0	1	0	1	1
1M	V ϕ	0	1	1	0	0	1	1	1
	V ₁	1	0	1	0	0	1	1	1
10M	V ϕ	0	1	1	0	1	1	1	1
	V ₁	1	0	1	0	1	1	1	1
100M	V ϕ	0	1	1	0	1	1	0	1
	V ₁	1	0	1	0	1	1	0	1
OHMS		1	1	1	1	1	1	1	1

Table 602-9. Ohms Converter PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N O T E
-02	OHMS CONVERTER PCB ASSEMBLY FIGURE 602-4 (MIS-4110T)	ORDER	BY	OPTION -02			
C1	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	4		
C2	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	REF		
C3	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	REF		
C4	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	REF		
C5	CAP, CER, 33 PF +/-2%, 100V	354852	80031	2222-638-10339	1		
C6	CAP, CER, 1200 PF +/-20%, 100V	358283	80031	2222-630-01-122	2		
C7	CAP, CER, 1200 PF +/-20%, 100V	358283	80031	2222-630-01-122	REF		
C8	CAP, POLYSTYRNR, 100 PF +/-10%, 500V	446609	89536	446609	1		
C9	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	7		
C10	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C11	CAP, TA, 22 UF +/-20%, 15V	423012	56289	196D226X0015KA1	1		
C12	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C13	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C14	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C15	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C16	CAP, TA, 5.6 UF +/-20%, 25V	368869	56289	196D565X0025KA1	1		
C17	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	3		
C18	CAP, TA, 0.47 UF +/-20%, 35V	161349	56289	196D474X0035HA1	1		
C19	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C20	CAP, CER, 0.0022 UF +/-10%, 500V	268425	32897	851000Z5R222K	1		
C21	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C22	CAP, TA, 0.33 UF +/-20%, 35V	408690	56289	196D334X0035HA1	1		
C23	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
CR1	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	6		2
CR2	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, SI, RECT	428144	01295	1N4006	7		2
CR7	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR8	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR9	DIODE, ZENER, UNCOMP	113324	07910	1N961A	2		1
CR10	DIODE, SI, MULTIPellet	375485	09214	MPD300	2		1
CR11	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR12	DIODE, SI, MULTIPellet	375485	09214	MPD300	REF		
CR13	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR14	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR15	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR16	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR17	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR18	DIODE, ZENER, UNCOMP	113324	07910	1N961A	REF		
CR19	DIODE, 2-PELLET	375477	09214	MPD200	1		1
CR20	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
E1	SURGE PROTECTOR, VOL	442723	25088	B1-C145	1		
H1	SCREW, PHP, 4-40 X 5/8	413062	89536	413062	1		
K1	RELAY, ARMATURE	515437	~~515429~~	515429	1		
K2	RELAY, DRY REED	357582	71707	UF40070	2		
K3	RELAY, DRY REED	357582	71707	UF40070	REF		
L1	CHOKE, RF	111542	99800	1537-76	1		

Table 602-9. Ohms Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N O T E
MP1	CASE ASSY (INCLUDES MP2-MP9)	458927	89536	458927	1		1
MP2	CASE HALF, MODULE	402990	89536	402990	REF		
MP3	CASE HALF, MODULE	402990	89536	402990	REF		
MP4	COVER, MODULE CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	411942	89536	411942	REF		
MP6	DECAL, OHMS CONVERTER	413435	89536	413435	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP11	SPACER, XSTR	152207	07047	10123-DAP	5		
MP12	SOCKET, COMPONENT LEAD (NOT SHOWN) (W/R20,R21,R23,R26)	343285	00779	2-331272-6	8		
MP13	LUG, SOLDER	103531	77963	501	1		
MP14	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380	1		
Q1	XSTR, SI, NPN	226290	04713	MPS3640	1	1	
Q2	XSTR, SI, NPN	218396	04713	2N3904	14	3	
Q3	XSTR, SI, PNP	195974	04713	2N3906	7	2	
Q4	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q5	XSTR, FET, N-CHANNEL	261578	89536	261578	4	1	
Q6	XSTR, SI, PNP	168716	07263	S19254	3	1	
Q7	XSTR, SI, PNP	168716	07263	S19254	REF		
Q8	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q9	XSTR, FET, DUAL, N-CHANNEL	476309	89536	476309	1	1	
Q10	XSTR, SI, NPN	203489	09214	11C2322	5	1	
Q11	XSTR, SI, NPN	203489	09214	11C2322	REF		
Q12	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q13	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q14	XSTR, SI, NPN	203489	09214	11C2322	REF		
Q15	XSTR, SI, NPN	203489	09214	11C2322	REF		
Q16	XSTR, SI, NPN	203489	09214	11C2322	REF		
Q17	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q18	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q19	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q20	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q21	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q22	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q23	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q24	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q25	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q26	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q27	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q28	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q29	XSTR, FET, N-CHANNEL	393314	89536	393314	4	1	
Q30	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q31	XSTR, FET, N-CHANNEL	393314	89536	393314	REF		
Q32	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q33	XSTR, FET, N-CHANNEL	393314	89536	393314	REF		
Q34	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q35	XSTR, FET, N-CHANNEL	393314	89536	393314	REF		
Q36	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		

Table 602-9. Ohms Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N O T E
Q38	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q39	XSTR, SI, PNP	168716	07263	S19254	REF		
Q40	XSTR, FET JUNCTION, N-CHANNEL	288324	89536	288324	1	1	
R1	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	7		
R2	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	6		
R3	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R4	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R5	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R6	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R7	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R8	RES, COMP, 220K +/-5%, 1/2W	109025	01121	EB2245	1		
R9	RES, COMP, 1.8K +/-5%, 1W	180331	01121	GB1825	2		
R10	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R11	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R12	RES, COMP, 100K +/-5%, 1W	109397	01121	GB1041	1		
R14	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R16	RES, MTL. FILM, 30.1K +/-1%, 1/8W	293431	91637	MFF1-83012F	1		
R17	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	6		
R18	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R19	RES, WW, 40K +/-0.1%	271403	89536	271403	2		
R20	RES, SELECTED				1		
R21	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	MFF1-8A100F	2		
R23	RES, SELECTED				REF		
R24	RES, VAR, CERMET, 100 +/-20%, 1/2W	267823	11236	190PC101B	1		
R25	RES, WW, 40K +/-0.1%	271403	89536	271403	REF		
R26	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	MFF1-8A100F	REF		
R27	RES, MTL. FILM, 20K +/-1%, 1/8W	291872	91637	MFF1-82002F	1		
R28	RES, DEP. CAR, 39K +/-5%, 1/4W	442400	80031	CR251-4-5P39K	2		
R29	RES, DEP. CAR, 39K +/-5%, 1/4W	442400	80031	CR251-4-5P39K	REF		
R30	RES, MTL. FILM, 11.3K +/-1%, 1/8W	335414	91637	MFF1-81132F	1		
R31	RES, MTL. FILM, 80.6K +/-1%, 1/8W	312710	91637	MFF1-88062F	1		
R32	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R33	RES, DEP. CAR, 180K +/-5%, 1/4W	348946	80031	CR251-4-5P180K	1		
R34	RES, MTL. FILM, 3.16K +/-0.1%, 1/8W	340588	91637	MFF1-83161B	1		
R35	RES, MTL. FILM, 21.5K +/-0.1%, 1/8W	344440	91637	MFF1-82152B	1		
R36	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	1		
R37	RES, VAR, CERMET, 50K +/-10%, 1/2W	330688	11236	190PC503B	1		
R39	RES, DEP. CAR, 1.6K +/-5%, 1/4W	348805	80031	CR251-4-5P1K6	1		
R40	RES, VAR, CERMET, 10K +/-10%, 1/2W	267880	11236	190PC103B	1		
R41	RES, WW, 4.091M +/-0.1%, 2W	412205	89536	412205	1		
R42	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R43	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R44	RES, VAR, CERMET, 500 +/-20%, 1/2W	267849	11236	190PC501B	1		
R45	RES, WW, 272.84K +/-0.08%, 1/2W	412197	89536	412197	1		
R46	RES, DEP. CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3	1		
R47	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	4		
R48	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	2		
R49	RES, COMP, 1.8K +/-5%, 1W	180331	01121	GB1825	REF		
R50	RES, DEP. CAR, 2.7K +/-5%, 1/4W	386490	80031	CR251-4-5P2K7	2		
R51	RES, DEP. CAR, 2.7K +/-5%, 1/4W	386490	80031	CR251-4-5P2K7	REF		

Table 602-9. Ohms Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N O T E
R52	RES, DEP. CAR, 150 $\pm$ 5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R53	RES, DEP. CAR, 1M $\pm$ 5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R54	RES, VAR, CERMET, 200K $\pm$ 20%, 1/2W	381509	11236	190PC204B	1		
R55	RES, MTL. FILM, 332K $\pm$ 1%, 1/8W	289504	91637	MFF1-83323F	1		
R56	RES, WW, 2.01K $\pm$ 0.1%, 1/2W	412189	89536	412189	1		
R57	RES, DEP. CAR, 1M $\pm$ 5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R58	RES, DEP. CAR, 1K $\pm$ 5%, 1/4W	343426	80031	CR251-4-5P1K	2		
R59	RES, DEP. CAR, 20K $\pm$ 5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R60	RES, MTL. FILM, 1M $\pm$ 1%, 1/8W	268797	91637	MFF1-81004F	1		
R61	RES, DEP. CAR, 120K $\pm$ 5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R62	RES, DEP. CAR, 120K $\pm$ 5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R63	RES, MTL. FILM, 15.8K $\pm$ 1%, 1/8W	293688	91637	MFF1-81582F	1		
R64	RES, MTL. FILM, 73.2K $\pm$ 1%, 1/8W	237222	91637	MFF1-87322D	1		
R65	RES, MTL. FILM, 30.1K $\pm$ 1%, 1/8W	168286	91637	MFF1-83012F	1		
R66	RES, DEP. CAR, 120K $\pm$ 5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R67	RES, DEP. CAR, 1K $\pm$ 5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R68	RES, DEP. CAR, 560K $\pm$ 5%, 1/4W	342642	80031	CR251-4-5P560K	1		
R69	RES, DEP. CAR, 300 $\pm$ 5%, 1/4W	441519	80031	CR251-4-5P300E	1		
R70	RES, DEP. CAR, 200K $\pm$ 5%, 1/4W	441485	80031	CR251-4-5P200K	1		
R71	RES, DEP. CAR, 470 $\pm$ 5%, 1/4W	343434	80031	CR251-4-5P470E	REF		
U1	⊗IC, C-MOS, NAND GATES	375147	02735	CD4023AE	1	1	
U2	⊗IC, C-MOS, QUAD, CLOCKED "D" LATCH	355149	02735	CD4042AE	2	1	
U3	⊗IC, C-MOS, QUAD, CLOCKED "D" LATCH	355149	02735	CD4042AE	REF		
U4	IC, LIN, OPNL AMPL	363515	34333	SG301A	1	1	
U5	IC, LIN, OPNL AMPL	418566	12040	LM358N	1	1	
U6	IC, RES NETWORK	380618	89536	380618	2	1	
U7	IC, RES NETWORK	380618	89536	380618	REF		

1 SEE TABLE 5-17 AT THE END

OF SECTION 5.

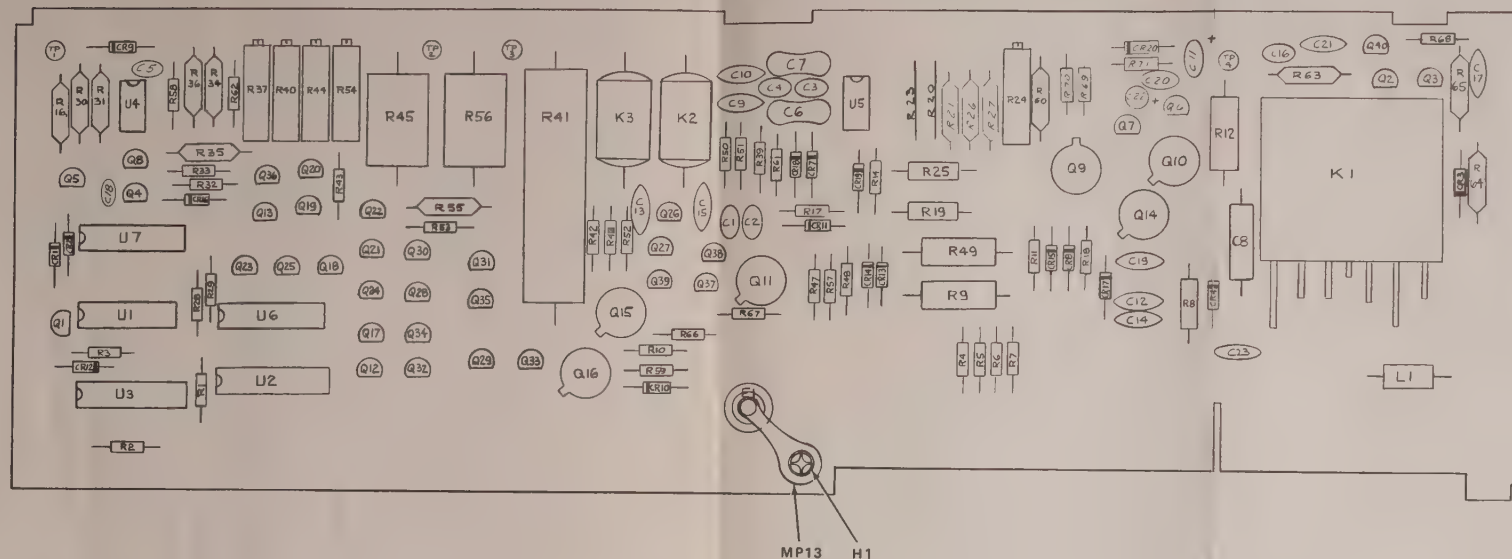


Figure 602-4. Ohms Converter PCB Assembly

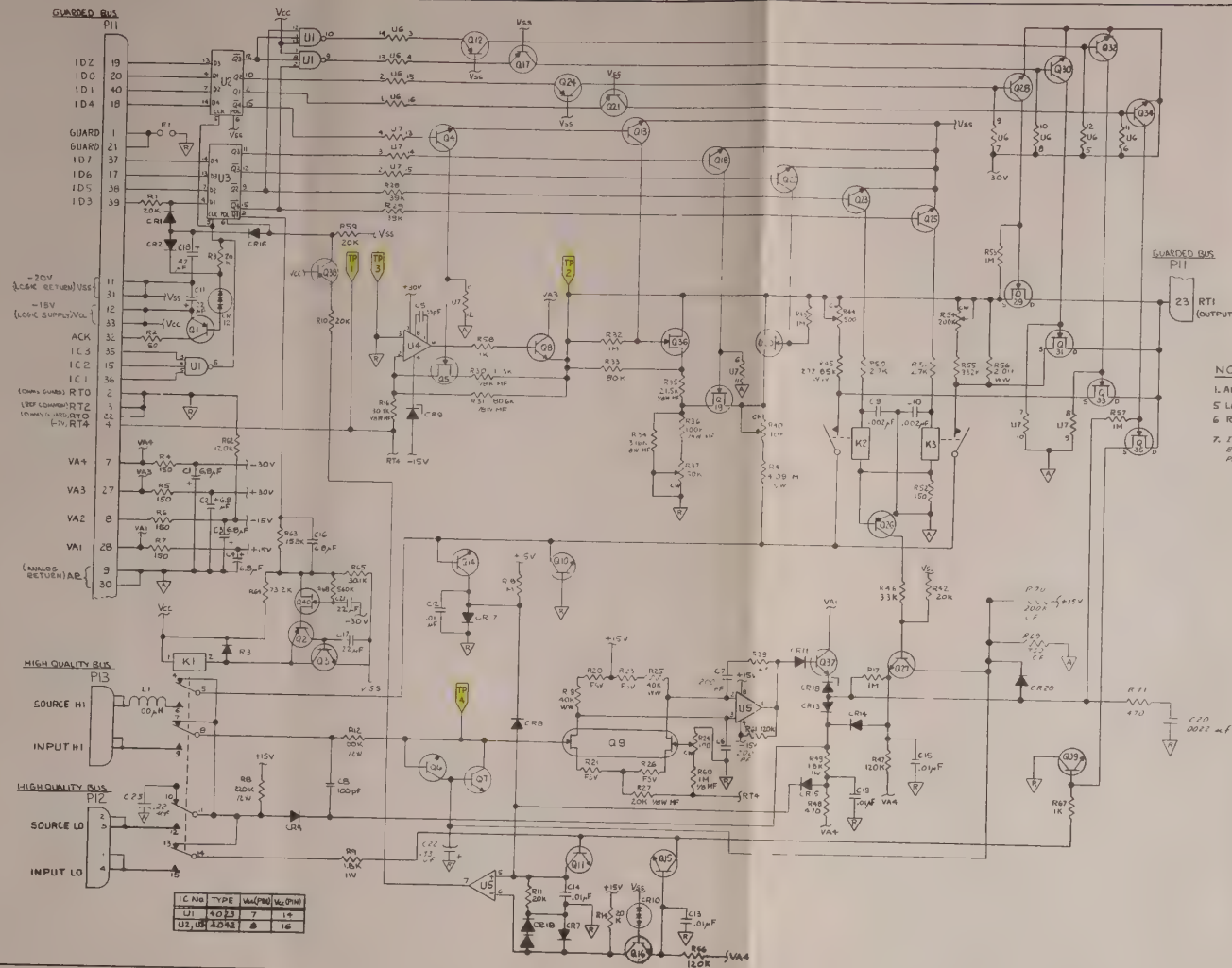


Figure 602-4. Ohms Converter PCB Assembly (cont)

Option —03 Current Shunts

603-1. INTRODUCTION

603-2. Installation of the Current Shunts module allows current measurement in five ranges: 100 μA , 1 mA, 10 mA, 100 mA, and 1 A. Either dc or ac current measurements may be made, but ac measurements require installation of one of the optional ac converters.

603-3. SPECIFICATIONS

603-4. Table 603-1 lists the specifications for the Current Shunts module. Accuracy specifications for the lower current ranges (100 μA , 1 mA, and 10 mA) depend on the source resistance of the current to be measured, due to the configuration of the measurement circuit. Source resistances only affect the number of floor digits, which can be determined from the formula given. For source resistances greater than specified, the number of uncertain digits will decrease. For ac currents, source resistance has a similar effect but the formula is much too complex for ordinary use.

603-5. INSTALLATION

603-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing the Current Shunts module. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

603-7. OPERATING NOTES

603-8. Operation of the front panel switches is the same as described in Section 2 of this manual. Inputs to the Current Shunts module are between Source HI and Source LO. Sense HI and Sense LO may be left connected with the shorting links provided.

603-9. THEORY OF OPERATION

603-10. The function of the Current Shunt module is to generate a voltage proportional to the current to be mea-

sured. Outputs from the Current Shunt module are applied either to the DC Signal Conditioner for dc currents or to an optional ac converter for ac currents.

603-11. Two modes of operation are used in the Current Shunt module, depending on the range selected. Figure 603-1 illustrates the two configurations and contains tables relating resistors, switches, and relays to each range. Mode A is used for the 100 μA , 1 mA, and 10 mA ranges. Input currents are applied to the summing node (virtual ground) of an operational amplifier through R4. R4 ensures stability when the current source is highly capacitive, while presenting a very low voltage burden. The formula given for determining floor digits (uncertainty) in the accuracy specifications is based on the feedback resistors used in the three lowest ranges. For source resistances less than approximately $10 \times R_{\text{FEEDBACK}}$, the gain of the circuit becomes greater than one for error sources such as offset voltages and current noise. Thus the basic uncertainty (digits) of a measurement increases as the source resistance decreases. The output voltage is equal to the input current multiplied by R_{FEEDBACK} .

603-12. Mode B configures the amplifier as a difference amplifier measuring the voltage across a shunt. The ratio of the feedback resistor, R66, to R_I sets the gain of the amplifier at approximately 20 [$R66/R_I = (R8 + R73)/R6$].

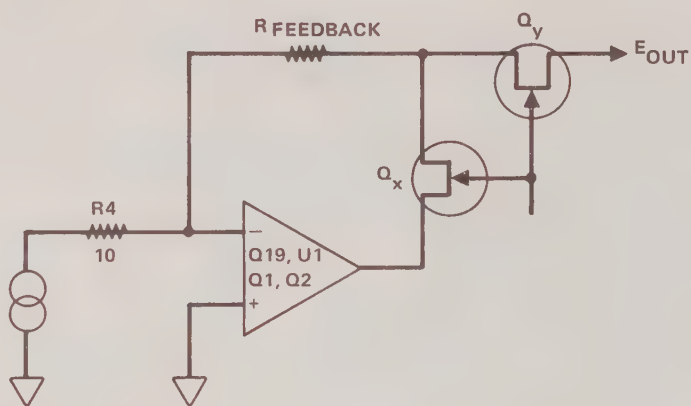
603-13. The amplifier consists of a dual FET (Q19), U1, Q1, and Q2. Refer to the schematic. R18 biases Q19 from the -7V reference (from the A/D Converter). R57 and R58 are selected to compensate for offset error (one of them will always be 10Ω). R55 and R56 are selected for temperature coefficient compensation. Q1 and Q2 are a complementary pair (for either polarity output) to increase the current output capability of the amplifier.

Table 603-1. Current Shunts Specifications

ACCURACY								
(Refer to the specifications table in Section 1 for required environmental conditions)								
DIRECT CURRENT								
RANGE	FULL SCALE	AT SOURCE ¹ RES. (R _s)	ACCURACY ±(% OF INPUT + NO. OF DIGITS ²)					
			24 HOURS	90 DAYS	1 YEAR			
100 uA	312 uA	80 kΩ	0.02 + 10	0.03 + 10	0.05 + 10			
1 mA	2.5 mA	10 kΩ	0.02 + 10	0.03 + 10	0.05 + 10			
10 mA	20 mA	1.25 kΩ	0.02 + 10	0.03 + 10	0.05 + 10			
100 mA	160 mA	—	0.03 + 20	0.05 + 20	0.1 + 20			
1 A	1.28A	—	0.03 + 20	0.05 + 20	0.1 + 20			
¹ For Source Resistance less than specified, replace floor digit specification with following:								
	Accuracy: Range	+ No. of Digits						
	100 uA	9 (1 + 8k/R _s)						
	1 mA	9 (1 + 1k/R _s)						
	10 mA	9 (1 + 125/R _s)						
² For high resolutuion multiply the number of digits by 10.								
ALTERNATING CURRENT								
Range	Full Scale	Frequency	Accuracy ±(% of Input + No. of Digits) from 0.1% of full scale to full scale:					
			24 Hours		90 Days		1 Year	
			Average Current	True RMS Current	Average Current	True RMS Current	Average Current	True RMS Current
100 uA *	312.5 uA	10 Hz—20 Hz	—	0.7 + 110	—	1.0 + 110	—	2.0 + 110
		20 Hz—50 Hz	0.55 + 9	0.55 + 35	0.8 + 9	0.8 + 35	1.6 + 10	1.6 + 35
		50 Hz—10 kHz	0.3 + 9	0.28 + 35	0.4 + 9	0.4 + 35	0.8 + 10	0.8 + 35
		10 kHz—20 kHz	0.5 + 9	0.7 + 110	0.7 + 9	1.0 + 110	1.5 + 10	2.0 + 110
		20 kHz—50 kHz	1.0 + 9	1.0 + 260	1.5 + 9	1.5 + 260	3.0 + 10	3.0 + 260
		50 kHz—100 kHz	2.0 + 9	2.8 + 760	3.0 + 9	4.0 + 760	6.0 + 10	8.0 + 760
1 mA * and 10 mA *	2.5 mA 20 mA	10 Hz—20 Hz	—	0.7 + 110	—	1.0 + 110	—	2.0 + 110
		20 Hz—50 Hz	0.35 + 9	0.35 + 35	0.5 + 9	0.5 + 35	1.0 + 9	1.0 + 35
		50 Hz—10 kHz	0.05 + 9	0.08 + 35	0.06 + 9	0.11 + 35	0.12 + 9	0.22 + 35
		10 kHz—20 kHz	0.08 + 9	0.14 + 110	0.11 + 9	0.2 + 110	0.22 + 9	0.4 + 110
		20 kHz—50 kHz	0.08 + 9	0.2 + 260	0.12 + 9	0.3 + 260	0.24 + 9	0.6 + 260
		50 kHz—100 kHz	0.35 + 9	0.7 + 760	0.51 + 9	1.0 + 760	1.0 + 9	2.0 + 760
100 mA	160 mA	10 Hz—20 Hz	—	0.7 + 150	—	1.0 + 150	—	2.0 + 150
		20 Hz—50 Hz	0.34 + 55	0.35 + 80	0.5 + 55	0.5 + 80	1.0 + 55	1.0 + 80
		50 Hz—10 kHz	—	0.18 + 80	—	0.26 + 80	—	0.52 + 80
		50 Hz—100 kHz	0.16 + 55	—	0.24 + 55	—	0.5 + 55	—
1A	1.28A	10 Hz—20 Hz	—	0.7 + 150	—	1.0 + 160	—	2.0 + 160
		20 Hz—50 Hz	0.34 + 65	0.35 + 90	0.5 + 65	0.5 + 90	1.0 + 65	0.5 + 90
		50 Hz—10 kHz	0.16 + 65	0.18 + 90	0.24 + 65	0.26 + 90	0.5 + 65	0.52 + 90
*Minimum Source Resistance, same as for Direct Current.								

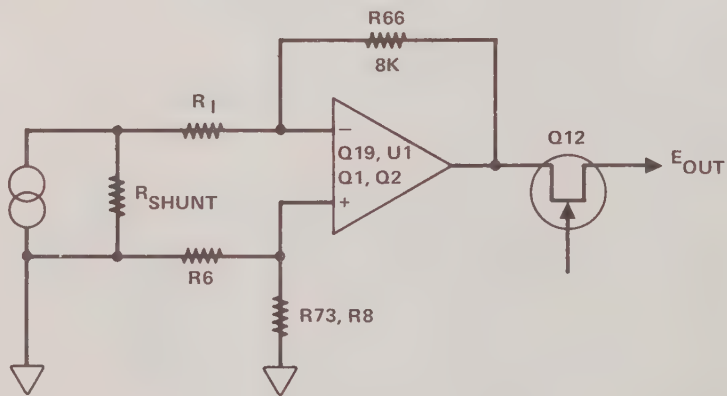
Table 603-1. Current Shunts Specifications (Continued)

OPERATING CHARACTERISTICS				
DIRECT CURRENT				
Range	Full Scale	At Source 1 Res. (R _S)	Temperature 2 Coefficient	
			Voltage Burden	± (ppm/rdg + No. of Digits)/°C ³
100 uA	312 uA	80 kΩ	≤100 mV	25 + 0.6
1 mA	2.5 mA	10 kΩ	≤100 mV	25 + 0.6
10 mA	20 mA	1.25 kΩ	≤200 mV	25 + 0.6
100 mA	160 mA	—	≤200 mV	35 + 0.6
1 A	1.28A	—	≤500 mV	35 + 0.6
1 For Source Resistance less than specified, replace Temperature Coefficient with the following:			2 0°C to 18°C and 28°C to 50°C.	
			3 For high resolution multiply No. of digits by 10	
Temperature Coefficient:		Range	+ No. of Digits/°C	
		100 uA	0.5 (1 + 8k/R _S)	
		1 mA	0.5 (1 + 1k/R _S)	
		10 mA	0.5 (1 + 125/R _S)	
OVERLOAD		PROTECTION		
1.5A maximum, ± 140V dc to 60 Hz, or 200V peak ac above 60 Hz on any range with no damage.		1-1/2A fuse		
		SETTLING & DIGITIZING TIME		
		Same as dc volts		
ALTERNATING CURRENT				
TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C)		VOLTAGE BURDEN		
		Same as dc current		
RANGE	TEMPERATURE COEFFICIENT		OVERLOAD	
	RMS AC	AVG. AC	1.5A maximum current (1-1/2A fuse protected) ± 140V dc to 60 Hz, or 200V peak ac above 60 Hz on any range with no damage.	
100 uA*	(50 ppm + 3.5 digits)/°C	(40 ppm + 1.5 digits)/°C		
1 mA*	(50 ppm + 3.5 digits)/°C	(40 ppm + 1.5 digits)/°C		
10 mA*	(50 ppm + 3 digits)/°C	(40 ppm + 1 digit)/°C		
100 mA	(50 ppm + 9 digits)/°C	(40 ppm + 7 digits)/°C		
1 A	(50 ppm + 9 digits)/°C	(40 ppm + 7 digits)/°C		
			CREST FACTOR (RMS only)	
			≤4.5 full scale, increasing down scale by:	
			$4.5 \sqrt{\frac{I_{\text{Range}}}{I_{\text{Input}}}}$	



MODE A – 100 μ A, 1 mA, 10 mA

RANGE	R FEEDBACK	Q _X	Q _Y	RELAYS	FULL SCALE E _{OUT}
100 μ A	R30, R31	Q30	Q31	K3, K4	.8 V
1 mA	R33, R34	Q7	Q10	K3, K4	1.0 V
10 mA	R36, R37	Q9	Q8	K3, K4	1.25 V



MODE B 100 mA, 1A

RANGE	R _{SHUNT}	R _I	RELAYS	FET SWITCHES	FULL SCALE E _{OUT}
100 mA	R2, R1	R7, R70, R71	K1, K3	Q20, Q32, Q29, Q12	1.6V
1 A	R1	R7, R68, R69	K2, K3	Q20, Q29, Q28, Q12	2.0V

Q11 and either Q3 or Q4 will be conducting in all ranges

Figure 603-1. Current Shunt Configurations And Range Information

603-14. Q11 and relay K3 are always closed for current measurements. Q3 and Q4 control the ground reference selection for the amplifier. In the dc mode, Q3 connects the noninverting input of the amplifier to reference common. In the ac mode the amplifier is referenced to the ac module ground (RT3) through Q4.

603-15. The Current Shunts module is addressed by IC0, 1, 3 high. At the first address, an ACK is returned and K5 is energized to sample the input voltage. If the voltage exceeds $\pm 45V$, one section of U6 will have a high output, depending on the input polarity. The output from U6 is stored on C10. At the next address the voltage on C10 will prevent the return of the ACK response and will prevent control data from being latched into U2. An Error 4 will be displayed. In addition to overvoltage protection provided by U6, overcurrent protection is provided by CR9 and CR10 in the 100 μA , 1 mA, and 10 mA ranges, and by CR5 and CR6 in the 100 mA and 1 A ranges. A fuse in series with the Source HI terminal is located on the front panel for additional overcurrent protection.

603-16. At the second address, if the input voltage did not exceed $\pm 45V$, termination of the address clocks range and reference control data into U2. Since relay common is Vcc, relay drivers must go low to energize a relay. FET switch drivers are configured to use a low from U2 to turn on the FET (close the switch) by turning off the gate control transistor.

603-17. MAINTENANCE

603-18. Performance Test

603-19. Test the direct current function by using the following procedure.

1. Select ADC and AUTO.
2. Connect the direct current source output HI to the instrument SOURCE HI and output LO to SOURCE LO.
3. Using Table 603-2, sequentially apply the inputs shown, manually selecting the range after the first reading. The instrument must read within the limits specified.

Table 603-2. Performance Test

Range	DC Input	Reading	
		Low (exp.)	High (exp.)
100 μA	10 μA	9.987 (–6)	10.013 (–6)
100 μA	100 μA	99.960 (–6)	100.040 (–6)
100 μA	250 μA	249.915 (–6)	250.085 (–6)
1 mA	0.1 mA	0.09987 (–3)	0.10013 (–3)
1 mA	1.0 mA	0.99960 (–3)	1.00040 (–3)
1 mA	2.0 mA	1.99930 (–3)	2.00070 (–3)
10 mA	1.0 mA	0.9996 (–3)	1.0004 (–3)
10 mA	10 mA	9.9960 (–3)	10.0040 (–3)
10 mA	15 mA	14.9945 (–3)	15.0055 (–3)
100 mA	10 mA	9.930 (–3)	10.070 (–3)
100 mA	100 mA	99.930 (–3)	100.070 (–3)
100 mA	150 mA	149.905 (–3)	150.095 (–3)
1 A	0.1 A	0.09975	0.10025
1 A	1 A	0.99930	1.00070

603-20. Calibration

603-21. Before calibrating any part of the instrument, the Calibration Memory module should be removed if installed. Apply power and allow a one hour warm-up period. All adjustments are on the Current Shunts module. DC calibration should be performed before calibrating current. Use the following procedure to calibrate the Current Shunts module.

1. Verify that the instrument is in the 1A range and the Cal mode (CAL indicator illuminated).
2. Connect the test DVM HI input lead to TP3 and the LO input to TP1.
3. The test DVM must read less than 200 mV.
4. Remove the test DVM.
5. Select the 100 mA range on the instrument.
6. Adjust R17 for a reading between -0.000-1 and +0.000-1 (0.000 $\pm$ 1 cal digit).
7. Set the current source controls for an output of 20.0000V dc.
8. Connect the instrument HI input to the current source HI output inserting a 200 k Ω $\pm$ 0.01% resistor in series with the instrument HI input lead. Connect the LO input terminal to the current source LO output.
9. Select the 100 μA range on the instrument and adjust R31 for a reading between +99.999 and +100.001.
10. Disconnect the instrument HI input lead from the current source, remove the inserted resistor and reconnect the HI input lead.
11. Select a current source output of +1.00000 mA.
12. Adjust R34 for a reading between +0.99999-0 and +1.00001-0.
13. Select a current source output of 10.0000 mA.
14. Adjust R37 for a reading between +9.9999-0 and +10.0001-0.
15. Select a current source output of 100.000 mA.
16. Adjust R4 for a reading between +99.999-0 and +100.001-0.
17. Select a current source output of 1.00000A.
18. Adjust R7 for a reading between +0.99999-0 and +1.00001-0.
19. Select the VDC function and Autorange on the instrument.

20. Select a 50V dc output from the current source.
21. Select the ADC function on the instrument.
22. ERROR 4 is displayed to show excessive voltage in the current function.

603-22. Troubleshooting.

603-23. Troubleshooting procedures for the Current Shunts module follow the format used for the mainframe instrument. Table 603-3 assures that the problem is in the

Current Shunts module. Figure 603-2, Symptom Analysis, lists symptoms and possible failures in the order of probability. Table 603-4 contains address and data information used to set up the module.

603-24. Always remove power before removing or installing modules.

603-25. PARTS LIST

603-26. Table 603-5 is a parts breakdown for the Current Shunts module. Refer to Section 5 of this manual for ordering and use code information.

Table 603-3. Current Shunts Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Perform DC Volts test (Section 4). Is DC within tolerance?	2	Section 4
2	Perform Current test. Is Current within tolerance?		3
3	Remove all optional modules except Isolator and Current Shunts. Is Current now within tolerance?	4	5
4	Replace modules one at a time, testing Current between modules. Last one in when Current goes bad is faulty. Go to appropriate subsection of Section 6.		
5	Remove Isolator. Install Interconnect/Monitor pcb. Is Current within tolerance?	6	7
6	Bad Isolator. Go to subsection 608.		
7	Bad Current Shunts module. Go to figure 603-2.		

Figure 603-2. Symptom Analysis

SYMPTOM	POSSIBLE FAILURE
Zero noisy or out of tolerance No zero reading Always zero 100 μ A, 1 mA, 10 mA ranges bad, others OK 100 mA, 1 A ranges bad, others OK High random — full-scale readings No display No ACK — Error 9 or Error 4 Only 100 μ A range bad Only 1 mA range bad Only 10 mA range bad Only 100 mA range bad Only 1 A range bad	Q21, Q20, Q29, U1, Q3, Q4, leaky output FETS K3, K4, Q19, U1, Q1, Q2 K3 or Q11 open K4 open, Q29, Q20, leaky protection diodes Q20, Q29, leaky protection diodes, Q12 Q19, U1, Q1, Q2 U5, U2 Voltage limit circuit, U6 or leaky diode (CR14, CR15), U5, Q18 Q30, Q31, Digital Control Q7, Q10, Digital Control Q8, Q9, Digital Control K2, Q32, Digital Control K2, Q28, Digital Control
Q19 DC Readings with Zero Input	
Drains (10 Ω resistors) $\simeq$ -0.6 V dc Sources (40 K Ω resistors) $\simeq$ 8.0 V dc U1 pin 6 $\simeq$ 0V dc	
Differences between ADC and AAC	
1. AC/DC Reference (ground) 2. Frequency response in AAC 3. RT1 outputs are applied to DC Signal Conditioner for DC and to optional AC module for AC (DC Signal Conditioner bypassed)	
If Q19, R15, R16, R55, or R56 are replaced, it is necessary to return the module to the factory (attn: PARTS) for temperature compensation.	

Table 603-4. Address and Data Field

Address — IC0, 1, 3 High						
	ID0	ID1	ID2	ID3	ID4	ID5
Current LO Input (K3) and Output FET (Q11)	X	X	X	0	X	X
DC Reference (Q3)	0	X	X	0	X	X
AC Reference (Q4)	1	X	X	0	X	X
100 μ A Range	X	1	1	0	1	1
1 mA Range	X	1	1	0	0	1
10 mA Range	X	1	1	0	1	0
100 mA Range	X	1	0	0	1	1
1A Range	X	0	1	0	1	1
Voltage Check	0	0	0	0	0	0
Reset	1	1	1	1	1	1

Table 603-5 Current Shunts Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	CURRENT SHUNTS ASSEMBLY Figure: 603-3						
C1, C2	Cap, Ta, 0.47 uF $\pm 20\%$, 35V	161349	56289	196D474X0035 HA1	2		
C3	Cap, mica, 47 pF $\pm 1\%$, 500V	284802	72136	DM15E470F	1		
C4	Cap, mica, 150 pF $\pm 5\%$, 500V	148478	72136	DM15F151J	1		
C5, C6	Cap, mica, 100 pF $\pm 5\%$, 500V	148494	72136	DM15F101J	2		
C7	Cap, cer, 1200 pF $\pm 20\%$, 100V	358283	80031	2222-630-01-122	1		
C8, C9	Cap, mica, 39 pF $\pm 5\%$, 500V	148544	72136	DM15E390J	2		
C10	Cap, Ta, 4.7 uF $\pm 20\%$, 25V	161943	56289	196D475X0025 KA1	1		
C11	Cap, Ta, 220 uF $\pm 20\%$, 6V	408682	56289	196D227X0006 TE4	1		
CR1, CR2, CR3, CR4, CR11, CR12, CR14 thru CR21	Diode, Hi-speed Switching	203323	07910	1N4448	14	4	
CR5 thru CR10	Diode, Si, Rect	347559	05277	1N5400	6	2	
CR22	Diode, zener	325803	07910	TD333408	1	1	
K1 thru K5	Coil, reed relay	269019	71707	U-6-P	5		
	Switch, wet mercury reed (use with K1- K4)	335737	95348	WR-126-26	4		
	Switch, dry reed	284091	95348	MR-138 MOD	1		
Q1, Q5, Q6, Q13 thru Q16, Q21, Q22, Q23, Q25, Q26, Q27	Xstr, Si, NPN	218396	04713	2N3904	13	3	
Q2, Q17, Q33	Xstr, Si, PNP	195974	04713	2N3906	3	1	

Table 603-5. Current Shunts Assembly (Continued)

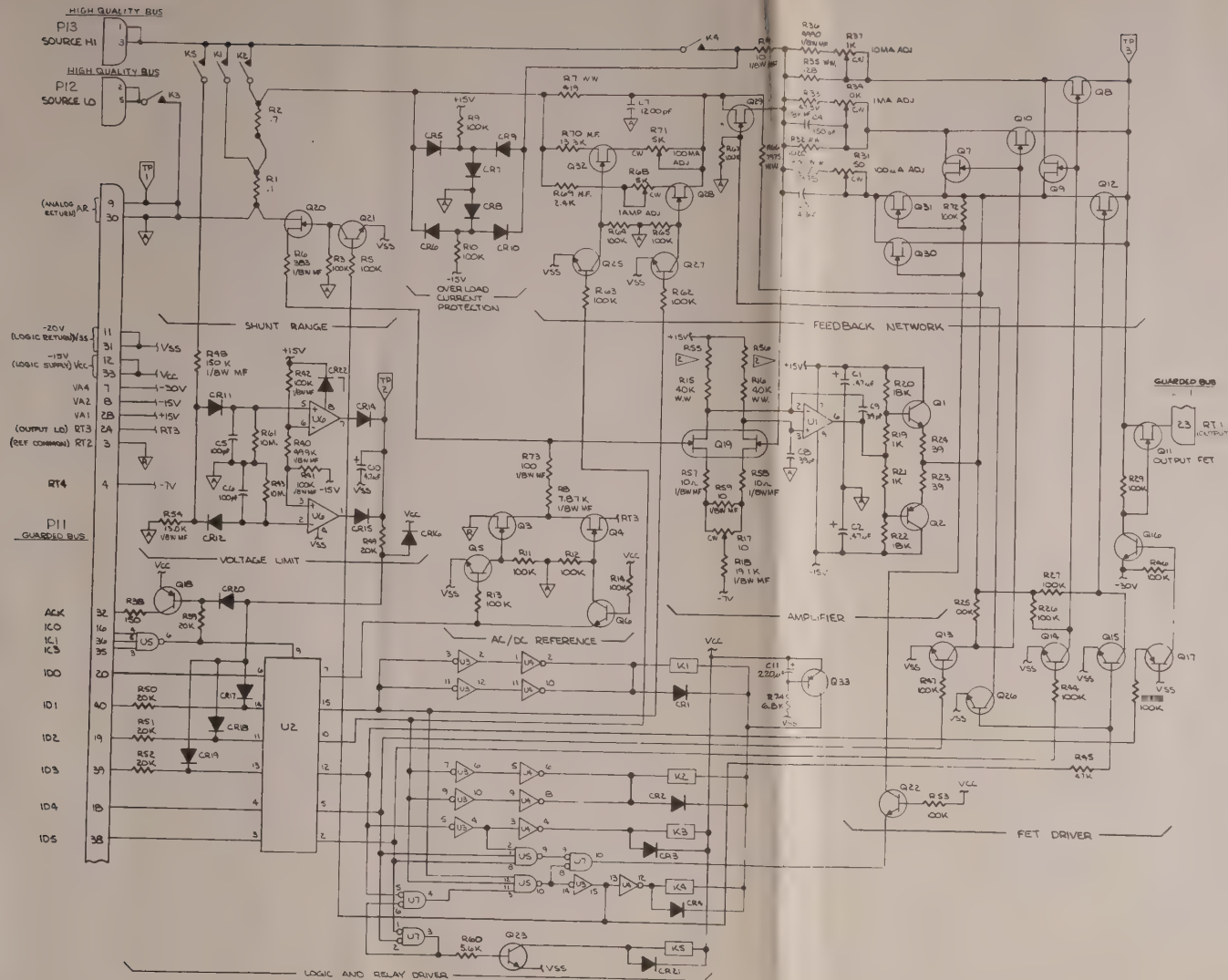
REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q3, Q4, Q7 thru Q10, Q12, Q20, Q28 thru Q32	Xstr, FET, N-channel	261578	89536	261578	13	3	
Q11	Xstr, FET N-channel	393314	89536	393314	1	1	
Q18	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
Q19	Xstr, FET, dual, N-channel (selected)	267963	89536	267963	1	1	
R1	Res, ww, 0.1 $\pm 0.05\%$, 1/2W	374611	89536	374611	1	1	
R2	Res, ww, 0.7 $\pm 0.1\%$, 1/4W	440404	89536	440404	1	1	
R3, R5, R9 thru R13, R25 thru R29, R44, R46, R47, R53, R62 thru R65, R67, R72	Res, comp, 100k $\pm 5\%$, 1/4W	148189	01121	CB1045	23		
R4, R57, R58, R59	Res, mf, 10 $\pm 1\%$, 1/8W	268789	91637	MFF1-8A100F	4		
R6	Res, mf, 383 $\pm 1\%$, 1/8W	375899	91637	MFF1-83830F	1		
R7	Res, ww, 419 $\pm 0.1\%$, 2W	440883	89536	440883	1	1	
R8	Res, mf, 7.87k $\pm 1\%$, 1/8W	294934	91637	MFF1-87871F	1		
R15, R16	Res, ww, 40k $\pm 0.1\%$	271403	89536	271403	2	1	
R17	Res, var, cermet, 10 $\pm 20\%$, 1/2W	344135	75378	190PC100B	1	1	
R18	Res, mf, 19.1k $\pm 1\%$, 1/8W	234963	91637	MFF1-81912F	1		
R19, R21	Res, comp, 1k $\pm 5\%$, 1/4W	148023	01121	CB1025	2		
R20, R22	Res, comp, 18k $\pm 5\%$, 1/4W	148122	01121	CB1835	2		
R23, R24	Res, comp, 39 $\pm 5\%$, 1/4W	193391	01121	CB3905	2		
R30, R66	Res, ww, 7975	440909	89536	440909	2	1	
R31	Res, var, cermet, 50 $\pm 20\%$, 1/2W	267815	75378	190PC500B	1	1	
R32	Res, ww, 1020 $\pm 0.05\%$, 0.2W	440891	89536	440891	1	1	

Table 603-5. Current Shunts Assembly (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R33	Res, mf, 47.5k $\pm 1\%$, 1/8W	289546	91637	MFF1-84752F	1		
R34	Res, var, cermet, 10k $\pm 20\%$, 1/2W	267880	75378	190PC103B	1	1	
R35	Res, ww, 128 $\pm 0.05\%$, 0.2W	440875	89536	440875	1	1	
R36	Res, mf, 4.99k $\pm 1\%$, 1/8W	168252	91637	MFF1-84991F	1		
R37	Res, var, cermet, 1k $\pm 20\%$, 1/2W	267856	75378	190PC102B	1	1	
R38	Res, comp, 150 ± 55 , 1/4W	147934	01121	CB1515	1		
R39, R49 thru R52	Res, comp, 20k $\pm 5\%$, 1/4W	221614	01121	CB2035	5		
R40	Res, mf, 49.9k $\pm 1\%$, 1/8W	268821	91637	MFF1-84992F	1		
R41, R42	Res, mf, 100k $\pm 0.5\%$, 1/8W	291054	91637	MFF1-81003D	2		
R43, R61	Res, comp, 10M $\pm 10\%$, 1/2W	108142	01121	EB1061	2		
R45	Res, comp, 47k $\pm 5\%$, 1/4W	148163	01121	CB4735	2		
R48	Res, mf, 150k $\pm 1\%$, 1/8W	241083	91637	MFF1-81503F	1		
R54	Res, mf, 13k $\pm 1\%$, 1/8W	335539	91637	MFF1-81302F	1		
R55, R56	Res, selected				2		
R60	Res, comp, 5.6k $\pm 5\%$, 1/4W	148080	01121	CB5625	1		
R68, R71	Res, var, cermet, 5k $\pm 20\%$, 1/2W	267872	75378	190PC502B	2	1	
R69	Res, mf, 12.4k $\pm 1\%$, 1/8W	261644	91637	MFF1-81242F	1		
R70	Res, mf, 13.3k $\pm 1\%$, 1/8W	296566	91637	MFF1-81332F	1		
R73	Res, mf, 100 $\pm 1\%$, 1/8W	168195	91637	MFF1-81000F	1		
R74	Res, comp, 6.8k 5%, 1/4W	148098	01121	CB6825	1		
U1	IC, Lin, Op-Amp	329912	12040	LM318H	1	1	
U2	⊗ IC, Dgtl, C-MOS, hex, "D", flip-flop	404509	12040	MM74C174N	1	1	
U3	⊗ IC, Dgtl, C-MOS, hex, inverter/buffer	381848	02735	CD4049AE	1	1	
U4	IC, TTL, hex inverter, buffer/driver	327775	01295	SN7416J	1	1	
U5	⊗ IC, Dgtl, C-MOS, triple, 3-input NAND gates	375147	02735	CD4023Ae	1	1	
U6	IC, Lin, Op-Amp, dual	418566	12040	LM358N	1	1	
U7	⊗ IC, Dgtl, COS/MOS, quad, 2-input NOR gates	355172	02735	CD4001AE	1	1	

Table 603-5. Current Shunts Assembly (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Casehalf, Module	402990	89536	402990	2		
	Cover, Module half	402974	89536	402974	1		
	Decal, Current Shunt	413419	89536	413419	1		
	Guard, front	383356	89536	383356	1		
	Guard, rear	383364	89536	383364	1		
	Shield, cover	412015	89536	412015	1		
	Socket, spring type	343285	00779	2-331272-6	8		
	Spacer PCB component (use with R7, R30, R32; R35, R66)	296319	32559	T0-8-06	10		



NOTES

1. ALL RESISTANCE IS IN OHMS AND ALL RESISTORS 1/8W C.C.
2. SELECT AT TEST
3. LAST REF. DES. NO.'S USED R74, C11, CR22, Q33, U7, K8
4. REF. DES. NO.'S NOT USED Q24, CR13, R49
5. FOR REF. DES. DRAWING SEE M.I.S.-1104
6. FOR PCB DETAIL DRAWING SEE M.I.S.-3104
7. FOR PCB ASSY. DRAWING SEE M.I.S.-4104
8. IF Q19, R15, R16, R55 OR R56 ARE REPLACED, IT BECOMES NECESSARY TO TC THE MODULE PER M.I.S.-1104.151 TEST PROCEDURE.

IC NO.	TYPE	VSS	VCC
U1	JM310	B	1
U2	74C174	B	1
U3	4024	7	1
U4	7414	7	1
U5	4025	7	1
U6	JM310	7	1
U7	4001	7	1

Figure 603-4. Current Shunt (M.I.S.1104)

Option —04 Calibration Memory

604-1. INTRODUCTION

604-2. Installation of the Calibration Memory module permits extended calibration intervals while maintaining the accuracy of the instrument. A calibration factor is entered into memory with a single keystroke. Calibration factors are determined by comparison to a standard at the cardinal point for each function and range. An input of +1.000000V dc would be the cardinal point for the 1V dc range. A non-volatile memory allows storage of calibration factors for at least one year or until the instrument is completely recalibrated.

604-3. SPECIFICATIONS

604-4. DC Zero, Ohms Zero, and calibration factors for the cardinal points of every range and function will be maintained for at least one year with no power applied to the instrument.

604-5. INSTALLATION

604-6. Refer to Section 4 of this manual under Module Installation and Removal for installation procedures. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

604-7. OPERATING NOTES

NOTE

If this option is being used in the 8502A, high resolution may be selected independently.

604-8. When the Calibration Memory module is installed, care must be exercised when using the instrument in the high resolution mode. Inadvertently depressing the STORE switch while in the high resolution mode will erase the cal factor for that function and range from memory and enter an erroneous factor. Use the following procedure to enter calibration factors.

1. Ensure that the DC Zero and Ohms Zero procedures have been performed.

2. Verify that the EXT REF and OFFSET indicators are extinguished.
3. Select the Cal mode (CAL indicator illuminated).
4. Select the desired function and range.
5. Apply an input from a calibration source equal to the value of the cardinal point at the function and range selected (e.g., with 10V dc selected apply +10.000000V dc).
6. Depress the STORE switch. The reading displayed should be equal to the value of the input $\pm$ the listed specification as long as the switch is held in.
7. Repeat steps 4, 5, and 6 for each applicable function and range.
8. Depress the RECALL switch to display the last uncorrected reading taken while in the Cal Memory mode. The reading is displayed until the switch is released.
9. To remove Calibration factors from the Cal Memory, use the foregoing procedure, except in step 5 use a short (an open for current factors) at the input terminals instead of the calibration source.

NOTE

Correction factors entered for the V ac rms feature automatically correct any reading in dc coupled ac.

604-9. THEORY OF OPERATION

604-10. The Calibration Memory module provides non-volatile read/write memory used to store calibration constants and dc and ohms zero factors. When the dc or ohms functions are selected, the appropriate zero factor (if one was entered) is brought out by the instrument controller for storage within the controller module. Likewise, when a new function or range is selected, calibration constants are read from and stored for immediate use within the controller module.

604-11. This module was designed for use in more than one instrument, so there are land patterns and some devices which are not used in this particular instrument on the pcb. The following discussion is keyed to the schematic, Figure 604-1.

604-12. RAM Location Addresses

604-13. RAM location addresses are sent to the Calibration Memory module on the instrument data bus, ID0-7. Address IC1, 2, 6 clocks the data into U23 through U15-10, and U14-12. Outputs from U23 determine the location in the RAMs that data will be written or read.

604-14. Write Operation

604-15. Addresses used in both read and write operations are true 3 of 7 codes in which three IC lines must be high and four low to obtain a response. Writing data into memory first requires an address (IC3, 4, 5 high) and a data key (ID 0, 3, 5, 6 high, ID 1, 2, 4, 7 low) to set the circuitry into the write mode. The address is decoded by U15-9, U14-1 ANDed by U13-3 (VA1). The data key is decoded by U24-13, U24-1 ANDed by U13-4 (KEY). VA1 and KEY are ANDed by U2-11 to produce the ACK response (U17, Q1) and to set U12-2 low (WRITE) through U25-10. The module is now set into the write mode.

604-16. The next address (IC0, 2, 6 high) is decoded by U15-6, U14-13 ANDed by U13-10 (VA2). VA2 triggers a one-shot multivibrator, U1-4, so U2-5, 6 are both low and VA2·WRITE is true (low) which sets the RAMs into the write mode. U12-1 is high so U2-3 is high which disables the outputs of the RAMs (OD). Data to be written into the RAMs accompanies this address and is stored in the memory location previously clocked into U23. At termination of the address, VA2 goes high clocking U12-1 low and U12-2 high, which sets the module into the read mode.

604-17. Read Operations

604-18. The module stays in the read mode unless set into the write mode. Read operations require the address resulting in VA2 as previously explained. This time U12-1 is low (READ). U2-3 goes low enabling the RAM outputs. U2-4 is high setting the RAMs (R/W) into the read mode. The desired memory location must have been clocked into U23 prior to the READ address.

604-19. TROUBLESHOOTING

604-20. Problems in the Calibration Memory can cause apparent problems in all functions of the instrument. The most common problem is wrong values entered. The recall feature may be used to determine the value of the stored correction factor. Since correction factors are multipliers, the stored value will be close to one and consequently difficult to display meaningfully. Instead, the last uncorrected reading is displayed when in the CAL mode, and the RECALL switch is depressed. Dividing the

cardinal value for the selected range into the last uncorrected reading results in the stored constant. By using the recall feature, it is fairly easy to determine if a reasonable cal constant is stored.

604-21. The three following checks may be made to determine if the Calibration Memory is functioning properly.

1. Store zeros for all functions and ranges, then recall the zero values.
2. Store cardinal points for all functions and ranges, then recall for the last uncorrected reading.
3. Remove power for two or more hours (to ensure that the RAMs have discharged C7 to the battery level), then reapply power and recall as in 1 and 2. This checks the shift of RAM power supply from Vcc to battery and back to Vcc. The purpose of C7 is to remove glitches in the RAM supply which can scramble entries stored in RAM.

604-22. Table 604-1 lists the test points found on the Calibration Memory module. Table 604-2 gives a symptom analysis approach to troubleshooting.

604-23. PARTS LIST

604-24. Table 604-3 gives a parts breakdown for the Calibration Memory module. Refer to Section 5 of this manual for ordering and use code information.

Table 604-1. Test Points

TP1 — Vss; logic return, use as LO return for test instrument
TP2 — VA2 · READ; low for the controller to read from cal memory goes low 3 or 4 times every 200 msec
TP3 — VA2 · WRITE; low for the controller to write into cal memory goes low 4 times for every STORE switch push
TP4 — RAM Supply Voltage; when power is on = Vcc — .6V when power is off = battery voltage
TP5 — Negative Battery Terminal
TP6 — Vcc; Logic Supply
TP7 — ACK; acknowledge signal returned when module addressed

Table 604-2. Symptom Analysis

SYMPTOM	POSSIBLE FAILURE
Won't Store	VA2 · WRITE missing; check TP3
Won't Read	VA2 · READ missing; check TP2
Error at Turn-On	Battery voltage bad at TP4, RAM defective, not reading
Wrong Readings	U23 (RAM address latch), RAM defective, wrong data stored

Table 604-3. Calibration Memory PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N O T E
-04	⊗CALIBRATION MEMORY PCB ASSEMBLY FIGURE 604-1 (8500A-4160T)	ORDER	BY	OPTION -04			
BT1	BATTERY, LITHIUM (USE WHEN R20 & CR4 ARE NOT INSTALLED)	448498	89536	448498	1		
BT1..	(CAUTION-DO NOT RECHARGE)						
BT1...	BATTERY, NI-CAD	412890	06001	PPS2092	1		
BT1..1	(USE WHEN R20, CR4, U9 & U21						
BT1..2	ARE INSTALLED)						
C2	CAP, TA, 0.47 UF +/-20%, 35V	161349	56289	196D474X0035HA1	1		
C3	CAP, MICA, 180 PF +/-5%, 500V	284786	72136	DM15F181J	1		
C5	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0035JA1	1		
C7	CAP, TA, 10 UF +/-20%, 15V	193623	56289	196D106X0015A1	1		
CR1	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	2	1	
CR4	DIODE, HI-SPEED SWITCHING (USE WITH NI-CAD BATTERIES INSTALLED)	203323	07910	1N4448	REF		
H1	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
MP1	MODULE CASE ASSY (INCLUDES MP2-MP9)	458919	89536	458919	1		1
MP2	CASE, HALF, MODULE	402990	89536	402990	REF		
MP3	CASE, HALF, MODULE	402990	89536	402990	REF		
MP4	COVER, MODULE CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	411975	89536	411975	REF		
MP6	DECAL, CALIBRATION MEMORY	413484	89536	413484	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP10	TIE, CABLE, NYLON (USED ON BT1)	172080	06383	SST-1M	2		
MP11	SOCKET, COMP, LEAD	343285	00779	2-331272-6	2		
MP12	SPRING, COIL	424465	83553	C0120=014-0380	1		
Q1	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
Q3	XSTR, SI, NPN	168716	89536	168716	1	1	
Q4	XSTR, FET, N-CHANNEL	370072	89536	370072	1	1	
Q5	XSTR, SI, PNP	195974	04713	2N3906	1	1	
R1	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R2	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R4	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	10		
R5	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R6	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R7	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R8	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R9	RES, MTL. FILM, 10K +/-1%, 1/8W	168260	91637	MFF1-81002F	1		
R12	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R13	RES, MTL. FILM, 34K +/-1%, 1/8W	261602	91637	MFF1-83402F	1		
R14	RES, MTL. FILM, 6.04K +/-1%, 1/8W	285189	91637	MFF1-86041F	1		
R15	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R20	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
R20.	(USE WITH NI-CAD BATTERIES INSTALLED)						
R21	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R22	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R23	RES, DEP. CAR, 10K +/-5%, 1/4W (USED WITH LITHIUM BATTERY)	348839	80031	CR251-4-5P10K	1		

Table 604-3. Calibration Memory PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N O T E
R25	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R26	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
RN1	RES, NETWORK	412908	89536	412908	2	1	
RN2	RES, NETWORK	412908	89536	412908	REF		
U1	IC, TTL, LO-POWER SCHOTTKY	404186	01295	SN74L123N	1	1	
U2	⊗IC, C-MOS, QUAD, 2-INPUT OR GATES	408393	18725	CD4071BE	1	1	
U3	⊗IC, C-MOS, DUAL PAIR PLUS INVERTER	408013	02735	CD4007AE	2	1	
U4	⊗IC, C-MOS, DUAL PAIR PLUS INVERTER	408013	02735	CD4007AE	REF		
U9	⊗IC, C-MOS, 1024 BIT STATIC RAM (USED WITH LITHIUM BATTERIES INSTALLED)	429860	34649	P5101L	2	1	
	⊗IC, C-MOS, 1024 BIT STATIC RAM (USED WITH NI-CAD BATTERIES INSTALLED)	408757	34649	P5101L-3	2	1	
U12	⊗IC, C-MOS, DUAL D-TYPE FLIP FLOP	340117	02735	CD4013AE	2	1	
U13	⊗IC, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE	1	1	
U14	⊗IC, C-MOS, DUAL, 4-INPUT NOR GATES	363820	02735	CD4002AE	1	1	
U15	⊗IC, C-MOS, TRIPLE, 3-INPUT AND GATES	408807	02735	CD4073B	1	1	
U17	⊗IC, C-MOS, DUAL 4-INPUT AND GATES	408799	02735	CD4082B	2	1	
U21	⊗IC, C-MOS, 1024 BIT STATIC RAM (USED WITH LITHIUM BATTERIES INSTALLED)	429860	34649	P5101L	REF		
	⊗IC, C-MOS, 1024 BIT STATIC RAM (USE WITH NI-CAD BATTERIES INSTALLED)	408757	34649	P5101L-3	REF		
U22	⊗IC, C-MOS, DUAL D-TYPE FLIP FLOP	340117	02735	CD4013AE	REF		
U23	⊗IC, C-MOS, HEX D-TYPE FLIP FLOP	404509	12040	MM74C174N	1	1	
U24	⊗IC, C-MOS, DUAL 4-INPUT AND GATES	408799	02735	CD4082B	REF		
U25	⊗IC, C-MOS, HEX, INVERTER/BUFFER	381848	02735	CD4049AE	1	1	
XR23	SOCKET, COMP, LEAD	343285	00779	2-331272-6	2		
XU9	SOCKET, IC, 22 PIN	453126	91506	322-AG39D	2		
XU21	SOCKET, IC, 22 PIN	453126	91506	322-AG39D	REF		

1 SEE TABLE 5-17 AT THE END
OF SECTION 5.

Option -05 IEEE-488 Interface

605-1. INTRODUCTION

605-2. This manual will specifically describe the IEEE Interface (Option -05); refer to the IEEE standard for general IEEE-488 bus interface information. Descriptions unique to the IEEE Interface will be presented separately from Programming Instructions in this manual. The Systems Multimeter Programming Card provided with the DMM lists condensed programming instructions. Refer also to Fluke Application Bulletins 25 and 36, and the IEEE Standard 488-1975 Digital Interface for Programmable Instrumentation.

605-3. SPECIFICATIONS

605-4. Specifications for the IEEE 488-1975 Standard Interface, Option -05, conform to those established in the IEEE Standard Digital Interface for Programmable Instrumentation as published by the Institute of Electrical and Electronics Engineers; 345 E. 47th Street, New York, N.Y. 10017. For an explanation of the IEEE 488-1975 Standard, refer to the Standard Document.

605-5. INSTALLATION

605-6. The IEEE-488 Interface is easily installed as a module in the 8500 Series DMM. Use the following installation procedure:

1. On the DMM, press power OFF and remove the line power cord.
2. Remove the DMM's top cover.
3. The Interface module fits in the rear slot, bus connector and address switches facing to the rear. Slide the module vertically between the module guides, and press firmly into place.

NOTE

Make sure the leaf spring, attached to one-half of the module shield, is resting firmly over the flange of the opposite half of the module shield.

4. If installed, remove the Interconnect PCB from slot K. This slot can be identified as the only slot with connectors on the analog and digital bus lines. To remove the Interconnect PCB, grasp the board at both ends and pull up. An end-to-end rocking motion may be necessary to free the PCB from its connectors.

5. The Isolator module must be installed in slot K whenever a remote interface (Option -05, -06 or -07) is used in the DMM.

NOTE

Use Isolator -08 with the 8500A; Isolator -08A must be used with the 8502A.

6. Connect the Interface to the IEEE-488 Bus. Attach a standard 24-pin cable to the bus connector accessed through the DMM's rear panel. Standard cables, listed in Table 605-1, are available from John Fluke Mfg. Co., Inc.
7. Optionally, connect the cable shield to chassis ground. The shield, pin 12 in the connector, is accessed from the rear panel via a banana jack. Chassis ground is available at a binding post on the DMM's rear panel.

8. Set the Interface address switches (A1-A5) as required. Controls and connections accessed through the rear panel are illustrated in Figure 605-1. Refer to Table 605-2 for permissible address settings. Depressing a switch to the bottom sets the associated address bit true (true = 1). TALK address bits T1 through T5 are equal to LISTEN address bits L1 through L5.

NOTE

If the other devices in the system are listeners only, the DMM may be placed in TALK ONLY mode by toggling the TALK/ADDRESSABLE switch; access to this switch is through the rear panel.

9. Replace the DMM's top cover.

10. Energize the DMM.

11. Remote operation can be entered by transmitting any character that the DMM will recognize from the remote controlling terminal. When remote operation is entered, use of DMM front panel switches (other than RESET or POWER) will be ignored.

Table 605-1. IEEE-488 Standard Cables

ORDER NUMBER	DESCRIPTION
Y8001	IEEE-488 Cable, 1 meter
Y8002	IEEE-488 Cable, 2 meters
Y8003	IEEE-488 Cable, 4 meters

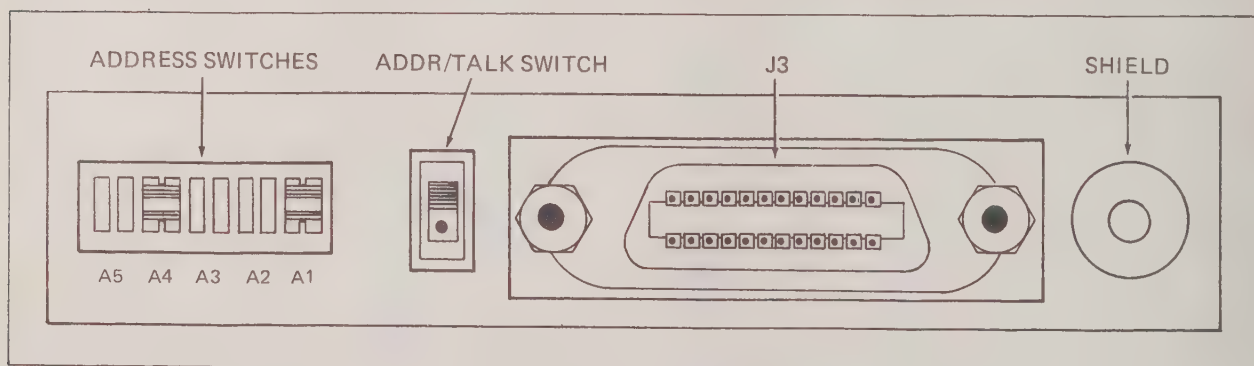


Figure 605-1. Rear Panel Access

Table 605-2. Allowable Listen and Talk Addresses

DECIMAL	5 4 3 2 1 BINARY	ASCII CHARACTER		DECIMAL	5 4 3 2 1 BINARY	ASCII CHARACTER	
		LISTEN	TALK			LISTEN	TALK
0	0 0 0 0 0	SP	@	16	1 0 0 0 0	0	P
1	0 0 0 0 1	!	A	17	1 0 0 0 1	1	Q
2	0 0 0 1 0	"	B	18	1 0 0 1 0	2	R
3	0 0 0 1 1	=	C	19	1 0 0 1 1	3	S
4	0 0 1 0 0	\$	D	20	1 0 1 0 0	4	T
5	0 0 1 0 1	%	E	21	1 0 1 0 1	5	U
6	0 0 1 1 0	&	F	22	1 0 1 1 0	6	V
7	0 0 1 1 1	'	G	23	1 0 1 1 1	7	W
8	0 1 0 0 0	(	H	24	1 1 0 0 0	8	X
9	0 1 0 0 1	)	I	25	1 1 0 0 1	9	Y
10	0 1 0 1 0	*	J	26	1 1 0 1 0		Z
11	0 1 0 1 1	+	K	27	1 1 0 1 1		[
12	0 1 1 0 0	,	L	28	1 1 1 0 0		]
13	0 1 1 0 1	-	M	29	1 1 1 0 1		^
14	0 1 1 1 0	.	N	30	1 1 1 1 0	>	^
15	0 1 1 1 1		O				

605-7. OPERATING FEATURES

605-8. Attached to the assembly and accessible through a port on the rear panel (Figure 605-1) are a standard specified connector, five address switches and a Talk Only Mode switch. The connector is standard for the IEEE bus and is specified by the standard document. The address of the instrument is set using the five address switches. The characters used to address the instrument in the talk and listen mode are given in Table 605-1. The five low order bits of the message determine the address, the next two higher bits differentiate between the Talk and Listen modes. Normal operation allows the instrument to both talk and listen to the bus. The Listen mode can be disabled with the Talk Only switch, if desired.

605-9. OPERATING NOTES

605-10. Interface Control

605-11. Information is input to the interface from the controller on the system bus, which contains eight data lines, three handshake lines and five bus management lines. Control of the handshake and management lines is from the controller and will vary with the controller used. Refer to the instructions with the system controller for the information on how to obtain the correct level on these lines. The lines and a brief explanation of their function are given in Table 605-3. Refer to the IEEE 488-1975 Standard Manual for a further explanation of their function.

605-12. Interface Messages

605-13. Multiple line messages are input to the interface from the controller using the data lines. The messages used within the instrument are listed with their codes in Table 605-4. Further information on the messages can be obtained from the IEEE 488-1975 Standard Manual.

605-14. Status Request Responses

605-15. If enabled by the applicable Interface Interrupt Enable Code, a service request (SRQ) can be generated within the interface by either an error or ready condition. When the instrument is addressed during a serial poll operation by the IEEE 488 Controller, and an interrupt is generated, the response byte will be a zero for ready or the numeric of the applicable Error Code. If the SRQ was not generated, the response is a null character (binary 00000000) to the controller.

605-16. THEORY OF OPERATION

605-17. The IEEE Interface provides for communication between the IEEE system bus and the DMM internal bus structure. The IEEE system bus is defined by the IEEE standard; the DMM internal bus structure is discussed in the instrument Instruction Manual. System bus signal lines will be referred to by their mnemonic designators (refer to Table 605-3 for definitions).

605-18. The IEEE Interface consists of two interconnected pcb's in one module. Each pcb will have its own reference designator system. To distinguish between the two, reference designators mounted on the Piggyback board will be followed by a (PB).

605-19. Data Lines

605-20. System bus data lines (DI01-08) are applied to the interface through receiver/drivers, U21 and U24. The receivers consist of noninverting buffers, while the drivers are gates with a common enable line from U32-8.

NOTE

True conditions on the system data bus are defined as a low; true conditions on the instrument bus are defined as a high.

Outputs from the data line receiver drivers are applied directly to address decoders, U19 and U12, through address switch S1 to address decoders U6 and U3, and through inverters to a data register consisting of U30 and part of U31.

605-21. The internal DMM data bus is applied to a response register consisting of U26 and U29. This register latches data up for application to the system bus lines (the system bus requires that data be held longer than is desirable to tie up the instrument controller). Instrument data is also applied to the control register on the Piggyback board (U11-PB, U16-PB, U14-PB).

605-22. Addresses

605-23. Instrument address lines (IC0-IC6) are applied to address decoders located on the Piggyback board. All of the following listed addresses cause an ACK to be returned to the instrument controller through U6 (PB)-1.

1. IC 1, 5 and 4 High: Decoded U12 (PB)-6 to enable the response register.
2. IC 6, 4 and 3 High: U12(PB)-10 to clock data into the control register; if ID0 is high, this address also causes a Return to Local signal from U8(PB)-3.
3. IC 5, 3 and 0 High: Decoded by U13(PB)-6 to cause a software reset through U8(PB)-10.
4. IC 6, 0 and 4 High: Decoded by U13(PB)-9 to enable the status register (U28 and part of U31).
5. IC, 6, 1 and 4 High: Decoded by U13(PB)-10 to enable the data register (U30 and part of U31).

605-24. Addresses to the IEEE Interface from the system are received on the data lines when ATN is true. Address switch S1 routes My Listen Address (MLA) and My Talk Address (MTA). Decoding for MLA is done by U6-13; the DAV signal clocks this address into U11-1. The MTA flip-flop U11-1 is cleared by the UNL (Unlisten) signal (decoded by U19-13). The Message Decoder (U9, U5 and U8) is enabled by the ATN and U12-10 (decoded by DI02, DI06, DI07).

Table 605-3. Mnemonics

PIN	MNEMONICS	FUNCTION	COMMENTS
1	DIO 1	Data	Data input/output lines. Message bytes are carried on the DIO lines in a bit-parallel byte-serial form, asynchronously, and generally in a bidirectional manner.
2	DIO 2	Data	
3	DIO 3	Data	
4	DIO 4	Data	
13	DIO 5	Data	
14	DIO 6	Data	
15	DIO 7	Data	
16	DIO 8	Data	
5	EOI	End Or Identify	Used to indicate the end of a multiple byte message.
6	DAV	Data Available	Is asserted TRUE by the sender of data when NRFD goes TRUE, remains TRUE until NDAC is sent TRUE by the data receiver.
7	NRFD	Not Ready For Data	When all devices are ready to receive data this line goes high. Remains high until DAV is sent TRUE.
8	NDAC	Not Data Accepted	When all receiving devices are through with the data on the bus, this line goes high, indicating that the sender may remove the data and set DAV low. When DAV goes to the receiving devices then pull NDAC low again.
9	IFC	Interface Clear	Sent high by the controller. It places all device interfaces in a known quiescent state.
10	SRQ	Service Request	This line is used by any device to get the attention of the controller.
11	ATN	Attention	Used by the controller to notify all other devices what type of message (interface versus device dependent) is on the data bus. When ATN is TRUE, messages sent are interface messages and all devices capable of receiving messages must handshake the transfer. When false, device dependent messages are sent and only devices that have been addressed remain active.
12		Shield*	Surrounds all conductors.
17	REN	Remote Enable	Must be TRUE to place instruments into remote. Once in Remote, if REN goes false all instruments must go to local.
18	GND	Return for DAV	
19	GND	Return for NRFD	
20	GND	Return for NDAC	
21	GND	Return for IFC	
22	GND	Return for SRQ	
23	GND	Return for ATN	
24	GND	Logic common for DIO 1-DIO 8, EOI, and REN	

**The cable shield is routed to a banana jack on the rear of the Option -05 interface adjacent to the programming conductor. This banana jack may be tied to the DMM chassis ground post located on the rear panel. However, caution must be exercised to prevent ground loops in the system.*

Table 605-4. Interface Messages

MNEMONIC	MESSAGE	CODING			ALL DEVICES RESPOND (Universal)	ADDRESSED DEVICES ONLY RESPOND	DEVICE IN LOCAL RESPONDS AND GOES TO REMOTE	NOTE
		BINARY	OCTAL	HEX				
MLA	My Listen Address	X F T A5 A4 A3 A2 A1				X	X	1
MTA	My Talk Address	X T F A5 A4 A3 A2 A1				X	X	1
UNL	Unlisten	X F T T T T T T	077	3F	X			
UNT	Untalk	X T F T T T T T	137	5F	X		X	
OTA	Other Talk Address	X X X X X X X X					X	2
SPE	Serial Poll Enable	X F F T T F F F	030	18	X		X	
SPD	Serial Poll Disable	X F F T T F F T	031	19	X		X	
LLO	Local Lockout	X F F T F F F T	021	11	X		X	
GTL	Go To Local	X F F F F F F T	001	01		X		
DCL	Device Clear	X F F T F T F F	024	14	X			
SDO	Selected Clear	X F F F F T F F	004	04		X		

605-25. Resets

605-26. Power-on or software resets may occur. At power-on, U8(PB)-10 causes an interface reset to prevent unwanted states in the interface logic. Software resets, decoded by U13(PB)-6, may occur as a result of a momentary power interruption, a front panel request, or a system request.

605-27. Control Register

605-28. The following six "D" flip-flops compose the control register:

1. Interrupt enable U14(PB)-2 remains true, except during the power-on routine.
2. A service request (SRQ) to the system controller is initiated by U14(PB)-13.
3. The instrument controller being ready for data (RFD) is indicated by U16(PB)-1.
4. At the last data byte of a message to the system from the instrument controller, U11(PB)-13 goes true.
5. Data accepted (DAC) is sent and RFD is reset by U16(PB)-13.
6. When the instrument is a talker, U11(PB)-2 is used to generate the data available (DAV) signal.

605-29. Status Register

605-30. The status register consists of U28 and part of U31. The instrument address decoded by U13(PB)-9 enables a status byte to be placed on the data bus (ID0-ID7). This status byte is defined as follows:

1. ID0: true from U28-7 when in the talk only mode.
2. ID1: true from U28-9 when remote enable (REN) from the system controller is false.
3. ID2: true from U28-9 when go to local (GTL) is true from the message decoder U5-4.
4. ID3: true from U28-3 for an interface message.
5. ID4: true from U31-3 for an interface message.
6. ID5: true from U31-5 to indicate a device dependent message.
7. ID6: true from U31-7 during the serial poll mode when the system controller is requesting status.
8. ID7: true from U31-9 when the system controller is requesting data from the instrument.

605-31. Message Decoder

605-32. Interface messages sent by the system controller on the data bus are decoded by U9, U5 and U8. The device dependent messages GET, SCD and GTL require the interface to be a listener before the instrument controller is interrupted. For group execute trigger (GET), U8-11 is true. For selected device clear (SDC), U8-10 is true. For go to local (GTL), U5-4 is true. The universal messages DCL and LLO are unique in that they cause the instrument controller to be interrupted when in local. For local lockout (LLO), U5-3 is true. For device clear (DCL), U5-10 is true. In addition, U8-4 goes true for the serial poll mode (SPE), and U8-3 is true for serial poll disable (SPD).

605-33. Mode Register

605-34. The mode register consists of the following four J-K flip-flops: U11-1 (clocks in MLA), U11-15 (clocks in MTA), U15-1 (true in remote mode) and U15-15 (true in serial poll mode).

605-35. Instrument Interrupts

605-36. Except during the power-on routine, interrupts are enabled by U14(PB)-2. The interrupt flip-flop may be clocked by the DAV signal through U4(PB)-4 and U4(PB)-3 or by U6(PB)-13 when the instrument is to be an active talker.

605-37. MAINTENANCE

605-38. Refer to Section 4 of the Instruction Manual for information on cleaning the module. The two pcb's are disassembled by removing the screws and standoffs

fastening them together. To prevent damage to the electrical connectors, pull the boards straight apart.

605-39. PERFORMANCE TEST

605-40. Operation of the IEEE Interface can be verified by programming changes in range, output and mode, and by observing response data.

605-41. CALIBRATION

605-42. The IEEE Interface does not require calibration.

605-43. TROUBLESHOOTING

605-44. Troubleshooting the -05 IEEE Remote Interface Option consists of the tabular flow chart in Table 605-5. When a step in the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

605-45. Programming Instructions

605-46. Programming commands and instrument responses are explained in Table 605-6.

605-47. PARTS LIST

605-48. Table 605-7 provides a detailed parts list for the Interface PCB; Table 605-8 lists parts for the Piggyback PCB. Refer to Section 5 of this manual for ordering information.

Table 605-5. Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	<i>NOTE</i> <i>Due to the speed and complexity of the data on the bus system, it is recommended that the pcb be sent to the nearest Fluke Service Center for repair when a problem is isolated to the interface. The following table will be of some assistance when troubleshooting simpler problems; however, many problems will require the use of a Fluke Trendar, or similar logic board tester. The instrument must be connected through a bus network to a system controller, e.g., the Tektronix 4051 or HP 9825, to operate.</i>		
1	This test is based on the assumption that the DMM was checked and found operational in local operation prior to installation of the IEEE Interface.		
2	Install the IEEE Interface Assembly in the instrument and apply power from the front panel switch.		
3	Is the front panel display correct?	6	4
4	If the display is blank, check the ACK circuit on the PB PCB.		
5	If the display is incorrect, check the input latches and output buffers on the Main PCB. Repair as required and return to step 2.		
6	Address the instrument on the IEEE bus with the applicable address. Does the instrument go into remote?	8	7
7	On the Main Board check the address lines through the Receiver/Driver, the address switches, the MLA circuitry, and the REN and DAV signals. On the Piggyback Board check the INT circuit. Repair as required then resume at step 2.		
8	Program an instruction from the remote controller. Is the output display as programmed?	10	9
9	Check the output latches and buffers, the UNL circuitry and the Receiver/Driver on the Main Board. Repair as required and return to step 8.		
10	Does the instrument respond to an "SRQ" from an Interrupt Ready or Error?	12	11
11	Check the SRQ line and the Receiver/Driver on the Main Board and the status latches on the Piggyback Board. Repair as required then resume at step 10.		
12	Does the interface clear from the system controller?	14	13
13	Check the IFC input and the IFC circuit. Repair as required, then resume at step 12.		
14	Can the Front Panel be locked out from the system controller?	16	15
15	Check the LLO line and the decoder circuit. Repair as required then resume at step 14.		
16	Troubleshooting of the IEEE Interface, as applicable at this level, is complete.		

Table 605-6. Programming Instructions

The programming instructions in this table pertain to the 8500 Series Digital Multimeters with the IEEE-488 Interface (Option -05), the Bit Serial Interface (Option -06) or the Parallel Interface (Option -07) installed. Features and instructions unique to the DMM model or to the Interface used will be identified in the following manner:

1. 8500A or 8502A: the symbol ◆ will denote an explanation applicable to one DMM model only. The software version incorporated in the DMM may also be mentioned for further identification. To verify the software version incorporated in your instrument, observe the display indication at power on or reset. For example, in the 8502A, "HI-2.0.2" will appear in the display for models with software version 2.0.2.
2. -05, -06, or -07 Interface Options: the symbol ● will be used with a feature or instruction unique to a particular Interface.

INITIALIZATION

When power is applied, or the Reset character (*) is transmitted, the instrument assumes a preset default condition. This condition is defined by the following remote codes:

REMOTE CODE	COMMAND
V	Volts DC
R4	1000V range
◆ S5 (8500A)	2 ⁵ Samples per Reading
◆ S7 (8502A)	2 ⁷ Samples per Reading
F0	Fast Filter, Timeout Disabled (Panel Indicator OFF)
X0	External Reference/Scaling Disabled
P0	Offset Feature Disabled
U0	Limits-Peak Value Storage Disabled
T0	Single Reading Line Synchronous
B0	Single Character ASCII Format
D0	Front Panel Display Active
L0	Deactivate Local Lockout
J0	Deactivate Line Feed Suppression
M0	Enable Cal Memory Factors
◆ Q0 (8502A)	Disable External Trigger
◆ W (8502A)	No Delay
● Y0 (-06 Option only)	Echo mode off (Bit Serial IF)

In addition, the following instrument states are assumed at power on or Reset:

Remote/Local	Local
Offset	Zeroed
V dc Zero	Zeroed or *
Ohms Zero	Zeroed or *
Cal Memory Factors	*
Peak Values	Cleared
Limits Values	Zeroed
Ext. Ref/Scaling Values	1
● 8/16 Bit Mode (-07 Option only)	8 Bit

*Retained if Cal Memory Opti. -04 installed

Table 605-6. Programming Instructions (cont)

PROGRAM SEQUENCE

When equipped with a remote interface option, the instrument is programmed through a sequence of commands ("command string") that will determine range, function, reading rate, etc. Examples of 5 possible command strings are:

1.

 Execute, trigger and transmit
 Slow filter, no time out
 2⁵ samples/reading
 10 volt range
 AC voltage
2.

 Execute, trigger and transmit
 Echo characters
 Turn display off
 Continuous line synchronized readings
3.

 Upper limit

 Execute
 Enter limits mode
 Lower limit
4.

 Clears command string to preceding "",","?" or ""@"
 2⁵ samples/reading
 Execute
 Auto range
 Ohms
5.

 Execute, trigger and transmit
 Get status and transmit on trigger
 Halt reading

Table 605-6. Programming Instructions (cont)

All command string characters transmitted via the remote interface must be ASCII 7-bit upper case characters. A command string is a sequence of 1 to 31 characters. Characters are classified as immediate, command or termination. The instrument may be placed in Remote mode by toggling the front panel REMOTE switch or by transmitting any character that the instrument will recognize from the remote controlling terminal.

- With the IEEE Interface installed, the REMOTE switch can only be used to select local mode if already in Remote.

REMOTE is the only front panel switch to remain active when in REMOTE mode; REMOTE may, however, be locked out by the local lockout command.

IMMEDIATE CHARACTERS

There are 5 immediate characters; each of these may be executed at any time and does not require a termination character.



Reset

This immediate character will reset the instrument to the conditions described under INITIALIZATION.

- ◆ When transmitted, the reset character must not be followed by any other character for 3 seconds with the 8502A (2 seconds with the 8500A). Any carriage return or line feed following the reset character must be suppressed. The remote interface will be unable to accept programming characters during this time.



Halt

The halt character is used to terminate the continuous mode and cause the instrument to wait for a command string. No other characters should precede the halt character if continuous mode is in effect. Upon receipt of the halt character, the transmission of readings is terminated immediately. The following trigger mode transitions will occur when halt is used:

From: Continuous Line Synchronous
To: Signal Reading Line Synchronous

From: Continuous Asynchronous
To: Single Reading Asynchronous



Go To Local - Lock Out Remote

- This character will command the instrument (Options -06 or -07 only) to enter local mode of operation and lock out the remote interface.
- The Remote mode may then be reentered by pressing the front panel REMOTE switch (for Option -06, -07). The Remote mode may not be reentered from the front panel when using the IEEE-488 Interface (Option -05).

Table 605-6. Programming Instructions (cont)

#

Go To Local-Lock Out Remote (cont)

The state of the instrument, when changing from remote to local operation will be modified as follows:

1. Ohms fast mode will be ignored.
- ◆ 2. Scaling mode will not be in effect (8500A only).
- ◆ 3. If the high averaged samples per reading rate was in effect, the samples per reading will be set to 2⁷ (8500A only).

The state of the instrument when changing from local to remote operation will be modified as follows:

1. Ohms fast mode (Z1) and continuous reading mode will be resumed if the DMM was in either mode when placed into local.
2. Any error that occurred during local operation will be stored and available for recall.

!

High Speed Reading Mode

- The "!" character can be used with the Parallel Interface (Option -07) (and with the IEEE-488 Interface Option -05 in the 8502A only). The High Speed Reading mode provides a shortened 3-byte binary two's complement format response representing the input to the DMM's A/D Converter. Speeds up to 500 readings per second are possible in this mode of operation.

True readings can be computed from this response using range and function dependent factors (refer to Fluke Application Bulletin 25).

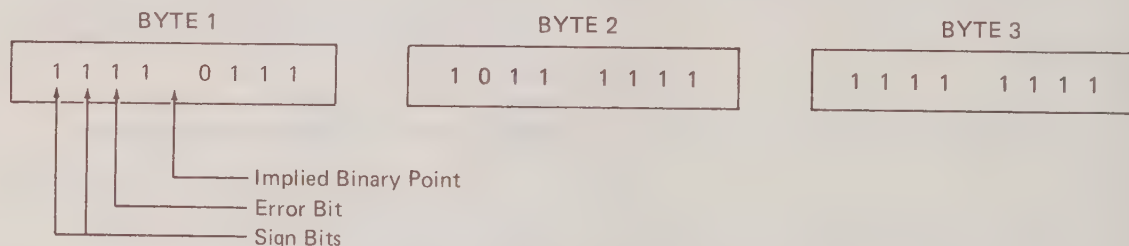
The High Speed Reading mode is suited to systems with very fast processors, to use with stored readings, or to applications not requiring direct numeric conversions (e.g., zero crossings or large deviations from a nominal value).

- ◆ Use of the "!" character will place the DMM in the High Speed Reading mode and trigger the first reading. Subsequent readings can be triggered by sending the "?" character. In addition, for the 8502A equipped with the -08A Option, subsequent readings can be triggered by sending the TTL pulse with the External Triggering Mode ("Q" or "Q1"). The High Speed Reading mode can be aborted at any time by transmitting a character other than "?" when a reading is to be triggered. The character sent in this case will do nothing more than cause the DMM to exit the High Speed Reading mode.

Table 605-6. Programming Instructions (cont)

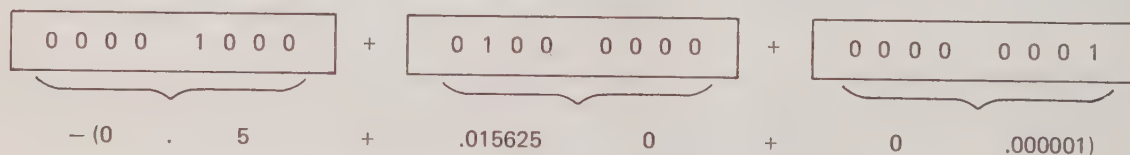
Voltage and Current Reading in "I"

The response data from the DMM will be in 3-byte format, as shown below, for each voltage or current reading. The first byte of this response contains sign and error bits, an implied binary point, and an implied scale factor of ten. Bytes 2 and 3 further define the reading. If the reading is negative, the sign bits will equal "1", and all three bytes must be two's complemented before conversion. If the error bit is equal to the complement of the sign bit, an error is defined.



In this example, the sign bits are "1" and the reading is negative. Since the complement of the sign bit does not equal the error bit ("1"), no error is defined.

To convert the response in this example, the two's complement must first be formed.



= 0.515626 X 10 (the implied scale factor)

Further conversion to calculate the true reading R_t necessitates multiplication of the A/D Converter reading (R_{AD}) by the scale factor for the instrument's range and function.

$$[R_t = R_{AD} \times \text{Scale Factor}]$$

Ohms Readings in "I"

The procedure for measuring ohms in High Speed Reading mode is more complex. High Speed Ohms readings differ from Fast Ohms (Z1) readings; when using the "I" character, the DMM will not compute the true reading. This conversion must be performed by the user. Up to 500 readings a second are possible when using High Speed Ohms. Refer to OPERATING NOTES, provided with Option -05 and -07 for High Speed Ohms Reading procedures.

**8/16 Bit Toggle**

The "/" character is used to toggle between the 8-bit and the 16-bit mode. When this character is used to toggle from one mode to another, the immediate and/or termination character must be placed in the least significant byte (LSB) of the programming word.

Table 605-6. Programming Instructions (cont)

TERMINATION CHARACTERS

Termination characters cause the execution of a command string. They are normally placed at the end of each programming statement.



Clear the Command String

● (Normally used only with the Bit-Serial Interface -06 Option.)

This character is used to erase an incorrect programming entry from the command string buffer, deleting all characters issued back to, but not including, the preceding termination character. A new command string is then needed to modify the state of the instrument.



Execute the Command String

This character is used to cause the execution of the previous command string. The instrument will then be in the defined state only; the character will not trigger a reading or produce a response from the instrument. When programming a string of characters, it is recommended that the execute character be used at frequent intervals; if an error is made, the string need then be cleared only back to the last execute character. This execute character is also required if a command string longer than 31 characters is used.



Execute the Command String and Trigger

This character will cause three actions: any previously entered command string will be executed, a reading will be taken, and that reading will be transmitted through the remote interface. If a command string was not entered immediately preceding this character, the instrument will take and transmit a reading in the last defined state.

An exception occurs when a command string containing a "Get" command has been entered; the instrument will then respond with the value or status that was requested by the command string (no reading will be triggered).

When issuing a program string terminated by the "?" character, the "CR" and/or "LF" delimiter characters should be, but do not have to be suppressed. If an error occurs during the reading, a single "0", followed by a "CR", will be transmitted. At this point, status should be requested to determine the cause of the error.



Execute, Trigger, and Interrupt when Ready

This character is used to trigger a reading and generate an interrupt when the reading is complete.

Table 605-6. Programming Instructions (cont)



Execute, Trigger, and Interrupt when Ready (cont)

- To provide the interrupt, the Bit-Serial Interface (Option -06) and the Parallel Interface (Option -07) transmit a single "CR". The IEEE-488 Interface (Option -05) provides an interrupt by generating a service request (SRQ).

The reading triggered by the "@" character can be obtained by inserting a "G" (get) command in the following command string (terminated by a "?").

The "@" character and the IEEE-488 Bus command "Group Execute Trigger" perform the same function.

COMMAND CHARACTERS

Command characters are classified within the following five groups:

1. FUNCTION
2. RANGE
3. MODIFIERS
4. CONTROL
5. MEMORY

FUNCTION COMMAND CHARACTERS

There are 7 function command characters. Whenever one of these characters is used, the state of the instrument will be changed as follows:

RANGE	Auto
MODIFIERS	Offset, Scaling, Limits, Peaks modes are turned off; stored values for these modes are retained.
MEMORY, CONTROL	Unchanged

If a function is selected requiring an optional module which is not loaded, the function of the instrument will be undefined, and the error code will be set to 19.



DC Volts



AC Volts



DC Coupled AC Volts



DC Current



AC Current

Table 605-6. Programming Instructions (cont)

Z Ohms

Z 1 Fast Ohms

The Z1 character will place the instrument into the ohms function and the fast ohms mode. In normal ohms operation, the unknown resistor value R_x is computed from the following measurements:

V1-V2: the voltage across an internal precision resistor (R_r)

V0: the voltage across the unknown resistor (R_x).

The value of R_x is then computed with Ohm's Law:

$$R_x = R_r \frac{V_0}{V_1 - V_2}$$

Fast Ohms mode differs in that the value of $\frac{R_r}{(V_1 - V_2)}$ is stored as a constant. The instrument will find R_x by measuring V_0 and multiplying this constant. The constant will change with a function change, range change or overload condition.

NOTE

Fast ohms ("Z1") differs from HIGH SPEED READING ("!"). When using "!" for ohms measurement, R_x is not computed by the DMM.

RANGE COMMAND CHARACTERS

The nine range commands specify the following maximum values by function.

	DC VOLTS	VA or C AC VOLTS	I or IA DC or AC CURRENT	Z or Z1 OHMS
R	Auto	Auto	Auto	Auto
R 0	312 mV	Auto	312 μ A	31.25 Ω
R 1	2.5V	2.5V	2.5 mA	250 Ω
R 2	20V	20V	20 mA	2 k Ω
R 3	160V	160V	160 mA	32 k Ω
R 4	1200V	1000V	1.28A	256 k Ω
R 5	Auto	Auto	Auto	4.096 M Ω
R 6	Auto	Auto	Auto	32.768 M Ω
R 7	Auto	Auto	Auto	262.144 M Ω

Table 605-6. Programming Instructions (cont)

MODIFIER COMMAND CHARACTERS

SAMPLES PER READING COMMAND CHARACTERS

The modifier command character "S" or "H" specifies the number of samples taken per reading. The times shown for these characters are approximate digitizing times per reading for 60 Hz line synchronous operation in dc volts, ac volts or current function.

S	0	$2^0 = 1$ Sample/Reading (4 ms)
S	1	$2^1 = 2$ Samples/Reading (8 ms) †
S	2	$2^2 = 4$ Samples/Reading (17 ms)
S	3	$2^3 = 8$ Samples/Reading (33 ms)
S	4	$2^4 = 16$ Samples/Reading (67 ms)
S	5	$2^5 = 32$ Samples/Reading (134 ms)
S	6	$2^6 = 64$ Samples/Reading (267 ms)
S	7	$2^7 = 128$ Samples/Reading (534 ms)
H	0	$2^8 = 256$ Samples/Reading (1.1s)
H	1	$2^9 = 512$ Samples/Reading (2.1s)
H	2	$2^{10} = 1,024$ Samples/Reading (4.3s)
H	3	$2^{11} = 2,048$ Samples/Reading (8.5s)
H	4	$2^{12} = 4,096$ Samples/Reading (17.1s)
H	5	$2^{13} = 8,192$ Samples/Reading (34.1s)
H	6	$2^{14} = 16,384$ Samples/Reading (68.3s)
H	7	$2^{15} = 32,768$ Samples/Reading (137s)
H	8	$2^{16} = 65,536$ Samples/Reading (273s)
H	9	$2^{17} = 131,072$ Samples/Reading (546s)

Table 605-6. Programming Instructions (cont)

FILTER COMMAND CHARACTERS

The "F" character is used to specify the type of filtering and the enabling of a time-out (for the filter settling time). This time-out causes a delay between a trigger command received and the actual reading taken. In the continuous trigger modes, the time-out will occur before each reading is initiated. The following "F" modifier command characters are used:

F		Slow filter, time-out disabled.
F	0	Fast filter, time-out disabled.
F	1	Bypass filter.
F	2	Slow filter, time-out enabled (approximately 500 ms).
F	3	Fast filter, time-out enabled (approximately 50 ms).

TRIGGER COMMAND CHARACTERS

The "T" characters specify the instrument's trigger mode. These characters determine whether samples taken are line synchronous (every 4 or 5 ms) or line asynchronous (approximately every 1.7 ms), whether single or continuous readings are to be taken.

T		Continuous reading mode/line synchronized.
T	0	Single reading mode/line synchronized.
T	1	Continuous reading mode/line asynchronous.
T	2	Single reading mode/line asynchronous.

NOTE

When line asynchronous modes are selected, the display will be turned off to save time; the front panel switches are then ignored.

- ◆ When in the continuous mode, any character (except "% " HALT) will be ignored by the instrument (8502A).

When in the Single Reading mode ("T0" or "T2"), and IEEE Group Execute Trigger command, a "?" or "@" character, or a TTL trigger (for the 8502A-08A) must be sent for each reading.

With the Continuous Reading mode ("T" or "T1"), use of the "GET" command, "?", "@" or a TTL trigger will start continuous readings.

Table 605-6. Programming Instructions (cont)

When each reading is accepted by the instrument controller, the next reading will be started. An exception to this sequence occurs in the "J1" Suppress Output mode; the next reading will now be taken immediately, without waiting for the output to the controller.

NOTE

The front panel display does not update in this mode unless the controller asks for a reading.

Use of the "%" character will halt the Continuous Reading mode and cycle the unit back to the Single Reading mode.

OFFSET COMMAND CHARACTERS

The "P" command characters specify whether an offset will be subtracted from a reading. The offset value may be entered by storing either a previous reading or a numerically entered offset.

- ◆ When storing readings, the 8500A will store the unprocessed reading, and the 8502A will store the displayed value.

Offset values may range from $\pm 1 \times 10^9$ to $\pm 1 \times 10^{-9}$ (including 0.0).

P Offset subtracted (ON).

P 0 Offset not subtracted (OFF).

EXTERNAL REFERENCE AND SCALING COMMAND CHARACTERS

The "X" command characters select External Reference or Scaling mode. Either mode is valid for any function and range. In External Reference mode, readings are divided by the signed magnitude of the external reference voltage. In Scaling mode, readings are divided by a numerically entered scale factor or by a previously read value.

X External Reference On, Scaling Off

The "X" External Reference mode uses the external reference voltage (Vxref) to divide the measured voltage. Vxref is measured during each reading cycle.

- ◆ Minimum Vxref = $\pm 0.0001\text{V}$ or the input divided by the maximum display with the volts range, whichever is greater (8500A only).
- ◆ For the 8502A, the minimum Vxref is the input divided by 10^9 .

Maximum Vxref = $\pm 40\text{V}$ between Ext Ref Hi and Lo terminals, providing neither terminal is greater than $\pm 20\text{V}$ relative to the Sense Lo or Ohms Guard Terminals.

Table 605-6. Programming Instructions (cont)

X **0** External Reference Off,
Scaling Off

X **1** External Reference Off,
Scaling On

The "X1" Scaling mode will divide all readings by a previously taken external reference voltage or by a previously entered numeric scale factor. The read valued may not be used as a scaling factor.

NOTE

The 8502A can store the external reference voltage and the numerical scale factor separately. The 8500A can only store one or the other, not both.

- ◆ Minimum scaling factor = the same as the minimum Vxref, for the 8500A.
- ◆ For the 8502A minimum = 10^{-9} . Factors less than this will be set to 0, which is not a valid scale factor.

Maximum scaling factor = ± 100 (8500A), or Input/Max Scale factor $< 10^{-9}$ (8502A).

NOTE

The "X" and "X1" modes are mutually exclusive.

LIMITS AND PEAKS COMMAND CHARACTERS

The "U" command characters specify selection of Limits or Peaks modes.

U Limits Testing On

When this command character is sent, each instrument reading is compared to upper and lower limits. Limit values must be entered separately with a keep command (refer to KEEP COMMAND CHARACTERS). The output format from the instrument (when given a "G" command) is as follows:

"0" is transmitted for a reading within limits.

"1" is transmitted for a reading greater than the upper limit.

"-1" is transmitted for a reading less than the lower limit.

"2" is transmitted if an error occurs (e.g., overranging).

U **0** Disable Limits and
Peak Mode(s)

U **1** Save Highest and Lowest
Values (Peaks On)

Previous peak values are erased from memory whenever the "U1" command character is programmed.

Table 605-6. Programming Instructions (cont)

U

1

Save Highest and Lowest Values (Peaks On) (cont)

◆ For the 8500A, storage of limit and peak values are mutually exclusive. For the 8502A, limit and peak values can be held in memory simultaneously.

NOTE

Limits are applied after all other modifier operations (Scaling, Offset, etc.) have been performed.

CONTROL COMMAND CHARACTERS

Output Format

The "B" characters activate binary or ASCII output format.

B

Single Byte Binary Format

B

0

Single Byte ASCII Format

B

1

Binary 16-Bit Parallel

B

2

16-Bit Parallel

"B1", "B2" used with Paralled ASCII Interface (Option -07) only.

The front panel DMM display is turned on when the ASCII mode is entered and off when the binary mode is entered.

The Binary Output Format

The binary output format consists of five bytes. The first four bytes comprise a 32-bit binary two's complement fixed point number. An implied binary point for this number is located between the first and second bytes. The first 8-bit byte thus serves as the integer portion. The 24 bits of the next 3 bytes serve as the binary fraction. Additionally, since this format cannot be used to hold the entire range of possible values for the DMM, a fifth byte is used as an exponent. This exponent is a two's complement binary number representing the decimal exponent of the binary fixed point number defined by the first 4 bytes. An exception occurs in Limits testing; the response will then be single byte binary two's complement number.

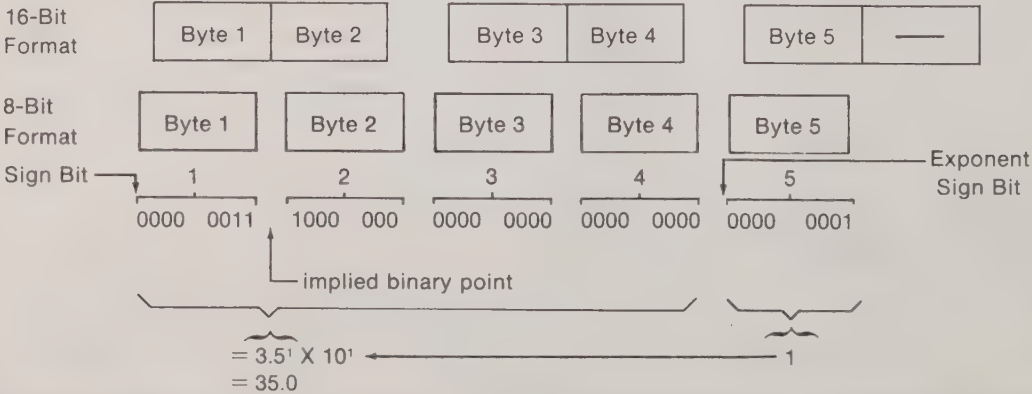
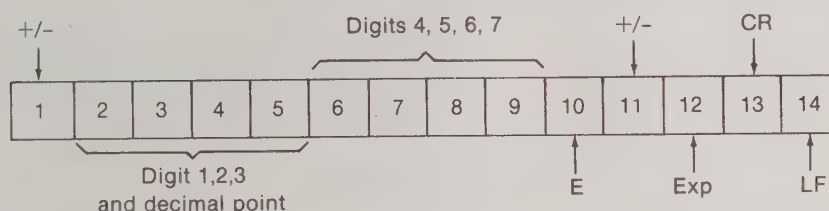


Table 605-6. Programming Instructions (cont)

NOTE

*In dc volts and ac volts, the exponent is always 1.
 In dc and ac current, the exponent is always -2.
 The exponent is range dependent in ohms
 function (1 for ohm ranges, 4 for kohm ranges,
 and 7 for Mohm ranges).*

Errors will be indicated by 5 bytes of 0.

ASCII Data Output Format

The seventh digit in the ASCII format corresponds to the "Cal" or HIRES digit of the front panel display. In some ranges and functions (e.g., 100 mV dc) this digit is permanently zeroed since it exceeds the resolution of the instrument). (When in the "Cal" or HIRES mode, the front panel will display the value of the reading rounded to six significant digits.)

DISPLAY CONTROL

The "D" command characters turn the DMM front panel display on or off.

D**Display Off****D****O****Display On**

When the "D0" command is used, the instrument will no longer interrogate any of the front panel switches (local lockout). The display will be turned On when the ASCII output format is commanded.

LOCAL LOCKOUT CONTROL

The "L" command characters select the local lockout condition, in which the display remains activated while none of the front panel switches affect the instrument.

L**Local Lockout On****L****O****Local Lockout Off****ECHO COMMAND CHARACTERS**

● (used with Bit Serial Option -06 only)

Y**ECHO ON (Full-Duplex)****Y****O****ECHO OFF (Half-Duplex)**

Table 605-6. Programming Instructions (cont)

LINE FEED CONTROL COMMAND CHARACTERS

J	Suppress Line Feed Character	This character suppresses the LF character normally sent at the end of a response line.
J 0	Transmit Line Feed Character	This character disables the "J" character; the "LF" character will be sent.
J 1	Suppress Output of Readings	◆ In the 8500A, use of J1 will suppress all output from the DMM. In the 8502A, use of J1 will suppress output with the following exceptions: Service Request (SRQ), status, recalled values. While in the J1 mode, use of the recall command "G ?" will retrieve a reading. Use of "J" or "J0" will exit the "J1" mode.

CALIBRATION CONSTANT

When the Calibration Memory (Option -04) module is installed, the "M" character will inhibit the adjustment of readings by the Calibration Memory correction factor. A slight increase in the speed of readings will result.

M	Inhibit Calibration Memory Factors
M 0	Enable Calibration Memory Factors

TRIGGER COMMAND CHARACTERS

◆ This set of command characters is available for the 8502A with the Isolator Option -08A.

Q	Activate External Triggering Mode, Interrupt when Ready	This character enables the External Triggering mode. Any external TTL trigger then initiates a reading and interrupts when ready (SRQ).
Q 0	Deactivate External Triggering Mode	
Q 1	Activate External Triggering Mode, Transmit when Ready	The Q1 character also enables External Triggering mode. Any external TTL trigger initiates and transmits a reading.

NOTE

The "?" and "@" characters remain operative during External Triggering.

Table 605-6. Programming Instructions (cont)

◆ **EXTERNAL TRIGGER DELAY COMMAND CHARACTERS**
 (-08A with 8502A only)

The "W" command characters select the amount of delay between the external trigger signal and the initiation of the reading.

W	No Delay	
W	0	2.083 ms
W	1	4.166 ms
W	2	8.332 ms
W	3	16.66 ms
W	4	33.33 ms
W	5	66.66 ms
W	6	133.3 ms
W	7	266.6 ms
W	8	533.2 ms
W	9	1.066s
W	1	0 2.133s
W	1	1 4.266s
W	1	2 8.532s
W	1	3 17.06s
W	1	4 34.13s
W	1	5 68.26s

Table 605-6. Programming Instructions (cont)

MEMORY COMMAND CHARACTERS

STORE

The "K" (Keep) command characters specify the storing of a reading or numeric entry.

K Store Last Reading as Offset ◆ The 8500A will store the unprocessed reading, whereas the 8502A will store the displayed reading.

K O Store Last Voltage Taken as VDC Zero (on R0 Only)

K 1 Store Last Reading as Ohms Zero (on R0 Only)

K N P Store Numeric Value Following as Offset

K N X Store Numeric Value Following as Scaling Factor
(Note: The read value may not be stored as a Scaling Factor.)

K N U Store Numeric Value Following as Upper Limit

K N L Store Numeric Value Following as Lower Limit

Offsets, Scaling Factors, Upper and Lower Limits may be entered via the "KN" command characters, followed by one of the modifier characters "P", "X", "U" or "L" and the numeric value (on ASCII string of numeric characters, and optional sign, decimal point and signed decimal exponent digit in "E" notation).

Examples of legal numeric strings are:

K N P 1 0
Keep Numeric offset of 10.0

K N X 1 0 . 3 E - 1
Keep numeric scaling factor of 10.3×10^{-1} or 1.03

K N U 7 . 6 E 4
Keep numeric upper limit of 7.6×10^4

K N L - 1 2 3 . 4 5 6 E + 0
Keep numeric lower limit of -123.456

Table 605-6. Programming Instructions (cont)

An example of an illegal numeric string is:

K N X 2 . 0 E . 1 3

Exponent is limited to one signed integer digit, in this case the exponent would be -1 and the "3" would be ignored.

NOTE

Numeric entries are limited to the maximum display value. These values are:

+1.00000 E+9 to +1.00000 E-9, and -1.00000 E-9 to -1.00000 E+9

Numbers less the $\pm 1.00000 E-9$ are treated as zero.

RECALL

The "G" (Get) command characters specify the recall of a reading, a numeric entry or a status. Each "Get" command must be followed by a "?" termination character. The following memory "Get" commands may be used:

G Recall Previous Reading and Send on Next Trigger

G 0 Recall DC Zero and Send on Next Trigger

G 1 Recall Status and Send on Next Trigger

Status information from the DMM may be obtained with the command character "G1?". The status response will be returned in the following seven character format.

Error Codes

1	2					
---	---	--	--	--	--	--

Characters 1 and 2 define error code status. Each error code contains two digits; those codes with a zero for the first digit are related to remote operation only. All other codes contain the same second digit as the DMM's front panel error codes.

- 00 No Error
- 06 System Error
- 07 Illegal Numeric Entry
- 08 Remote Command String Error
- 09 Remote Overrange/Underrange
- 10 V DC Zero/Ohms Zero Error
- ◆ 11 Offset Error (8500A) Store during Overrange (8502A)

Table 605-6. Programming Instructions (cont)

Error Codes (cont)

- 12 Filter Module Faulty or not installed
- 13 DC Signal Conditioner Module Faulty or not installed
- 14 Excessive voltage present at terminals for Ohms/Current Measurement
- 15 Fast A/D Converter Faulty or not installed
- 16 Numeric Display Overflow
- 17 Magnitude of External Reference Input >20V
- 18 Controller Module Faulty
- 19 Function Module selected not installed

Range Codes

		3				
--	--	---	--	--	--	--

The third character of the status response contains the following range information:

- 0 100 mV dc, 100 μ A, 10 Ω
- 1 1V dc, 1V ac, 1 mA, 100 Ω
- 2 10V dc, 10V ac, 10 mA, 1k Ω
- 3 100V dc, 100V ac, 100 mA, 10 k Ω
- 4 1000V dc, 1000V ac, 1A, 100 k Ω
- 5 1 M Ω
- 6 10 M Ω
- 7 100 M Ω

Sample Codes

			4			
--	--	--	---	--	--	--

The fourth status response character contains sample information identified by the following codes:

- 0 1 Sample per Reading
- 1 2 Samples per Reading
- 2 4 Samples per Reading
- 3 8 Samples per Reading
- 4 16 Samples per Reading
- 5 32 Samples per Reading
- 6 64 Samples per Reading
- 7 128 Samples per Reading or Greater

Function Codes

				5	<CR>	<LF>
--	--	--	--	---	------	------

The fifth response character identifies function:

- 0 DC Volts
- 1 AC Volts
- 2 DC Amps
- 3 AC Amps
- 4 Ohms
- 5 DC Coupled AC Volts
- 7 Function Not Defined

Table 605-6. Programming Instructions (cont)

G **N** **P** Recall Offset and Send on Next Trigger

◆ **G** **N** **X** Recall External Ref or Scaling Factor and Send on Next Trigger (8500A)
Recall Scaling Factor (8502A)

◆ **G** **N** **R** Recall External Reference Factor and Send on Next Trigger (8502A)

G **N** **U** Recall Upper and Send on Next Trigger

G **N** **L** Recall Lower Limit and Send on Next Trigger

NOTE

*The instrument will replay to "GNU" or
"GNL" by transmitting the stored limit
value.*

G **N** **Q** Recall Lowest (Peak) Value Found and Send on Next Trigger

G **N** **W** Recall Highest (Peak) Value Found and Send on Next Trigger

Table 605-7. IEEE-488-1975 Interface PCB Assembly

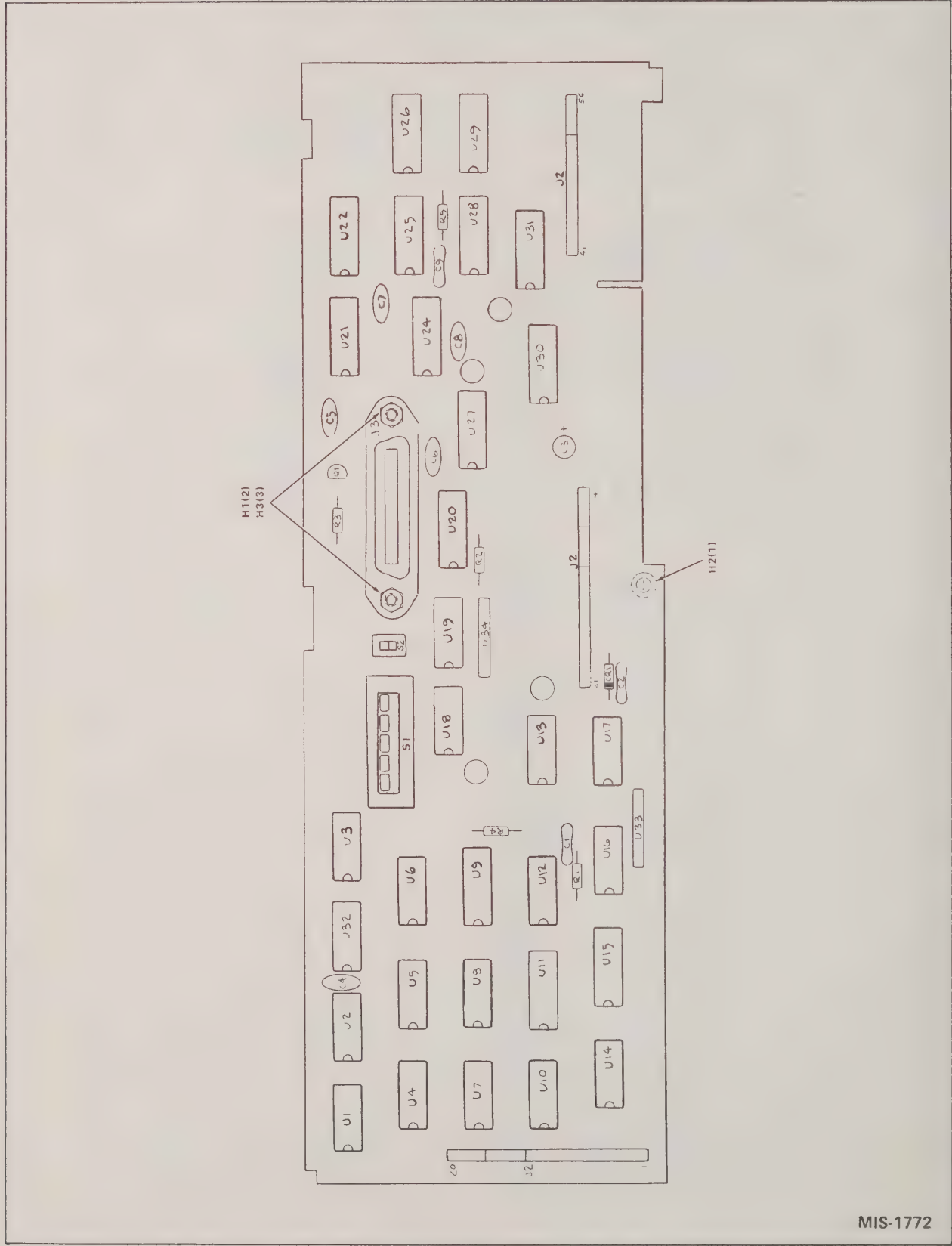
REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N O T E
-05	①IEEE 488-1975 INTERFACE PCB ASSEMBLY FIGURE 605-2 (MIS-4172T) IEEE 488-1975 PIGGYBACK PCB ASSEMBLY FIGURE 605-3 (MIS-4074)	ORDER	BY	OPTION -05			2
C1	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	2		
C2	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	REF		
C3	CAP, TA, 10 UF +/-20%, 15V	193623	56289	196D106X0015KA1	1		
C4	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	5		
C5	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	REF		
C6	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	REF		
C7	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	REF		
C8	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	REF		
C9	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
CR1	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	1	1	
H1	LOCKWASHER, SPLIT, 8-32	111070	89536	111070	2		
H2	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
H3	SCREW, CONN MTG, (USE ON J3)	429472	89536	429472	2		
J2	POST, CONTACT	447813	22526	65501-136	3		
J3	CONN, CABLE, 24-PIN, MODIFIED	534107	89536	534107	1		
MP1	CASE ASSY (INCLUDES MP2-MP8)	458935	89536	458935	1		1
MP2	CASE HALF, MODULE	402990	89536	402990	REF		
MP3	CASE HALF, MODULE, MODIFIED	456079	89536	456079	REF		
MP4	COVER, MODULE CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	441022	89536	441022	REF		
MP6	DECAL, IEEE INTERFACE ASSY	413518	89536	413518	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	COIL, SPRING (NOT SHOWN)	424465	83553	C0120-014-0380	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	1	1	
R1	RES, DEP. CAR, 18K +/-5%, 1/4W	348862	80031	CR251-4-5P18K	1		
R2	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	1		
R3	RES, DEP CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
R4	RES, DEP CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	1		
R5	RES, DEP CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	1		
S1	SWITCH, MODULE SPDT, 5-POS.	417766	00779	435470-4	1	1	
S2	SWITCH, SLIDE, SPDT	417287	95146	MSS-1040-1	1	1	
U1	①IC, C-MOS, QUAD, 2-INPUT NAND GATE	355198	02735	CD4011AE	1	1	
U2	①IC, COS/MOS, DUAL, 4-INPUT, NOR GATES	363820	02735	CD4002AE	1	1	
U3	①IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE	3	1	
U4	①IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	2	1	
U5	①IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	3	1	
U6	①IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE	REF		
U7	①IC, COS/MOS, TRIPLE, 3-INPUT NOR GATES	355180	02735	CD4025AE	1	1	
U8	①IC, COS/MOS, QUAD, 2-INPUT, NOR GATES	355172	02735	CD4001AE	REF		
U9	①IC, C-MOS, DCDR/MULTIPLEXER	408369	04713	MC14556CP	1	1	
U10	①IC, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE	1	1	
U11	①IC, COS/MOS, DUAL, JK MASTER FLIP FLOP	355230	02735	CD4027AE	2	1	
U12	①IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	02735	CD4023AE	1	1	

Table 605-7. IEEE-488-1975 Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N O T E
U13	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	2	1	
U14	⊗IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U15	⊗IC, COS/MOS, DUAL, JK MASTER FLIP FLOP	355230	02735	CD4027AE	REF		
U16	⊗IC, C-MOS, QUAD, 2-INPUT, NAND	404632	02735	CD4093BE	1	1	
U17	⊗IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	REF		
U18	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U19	⊗IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE	REF		
U20	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	4	1	
U21	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	REF		
U22	⊗IC, C-MOS, HEX INVERTER BUFFER	381848	02735	CD4049AE	2	1	
U24	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	REF		
U25	⊗IC, C-MOS, HEX INVERTER BUFFER	381848	02735	CD4049AE	REF		
U26	⊗IC, COS/MOS, QUAD, LOCKED D LATCH	355149	02735	CD4042AE	2	1	
U27	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	REF		
U28	⊗IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N	3	1	
U29	⊗IC, COS/MOS, QUAD, LOCKED D LATCH	355149	02735	CD4042AE	REF		
U30	⊗IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N	REF		
U31	⊗IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N	REF		
U32	IC, TTL, QUAD, 2-INPUT NAND GATES	393033	01295	SN74LS00N	1	1	
U33	RES. NETWORK, 4.7K	412916	89536	412916	2	1	
U34	RES. NETWORK, 4.7K	412916	89536	412916	REF		

1 SEE TABLE 5-17 AT THE END
OF SECTION 5.

2 ONE OR THE OTHER WILL BE INSTALLED.

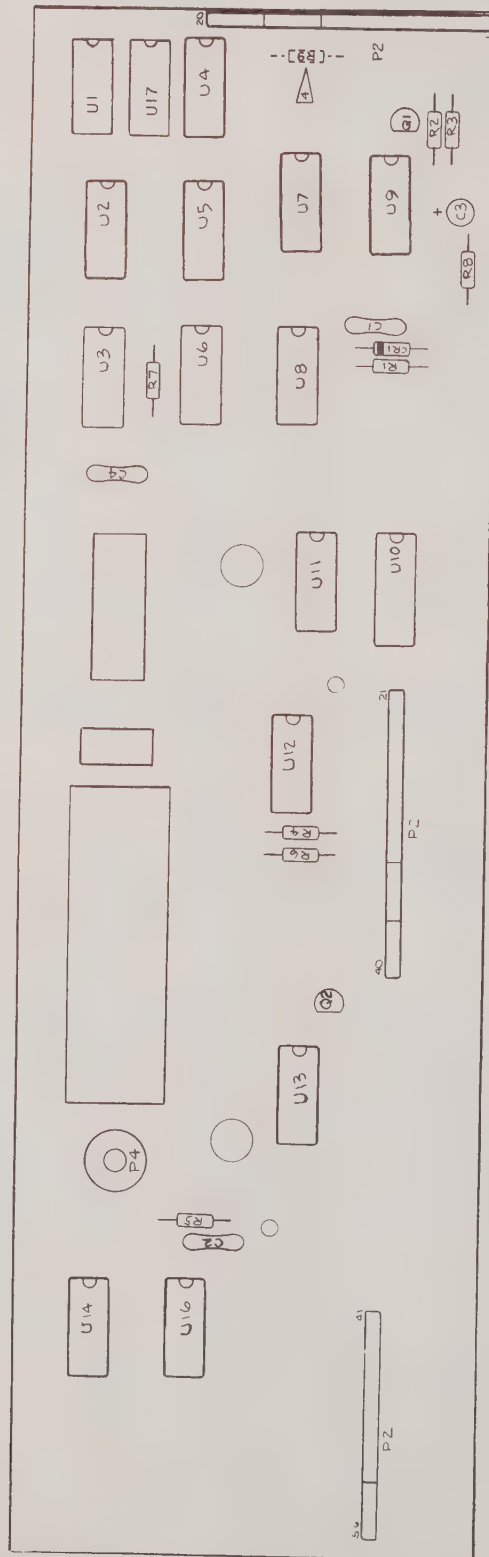


MIS-1772

Figure 605-2. IEEE-488-1975 Interface PCB Assembly

Table 605-8.. IEEE-488-1975 Piggyback PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N O T E
-05P	IEEE-488-1975 PIGGY BACK PCB ASSEMBLY FIGURE 605-3 (MIS-4074)	PART	OF	OPTION -05			
C1	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	2		
C2	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
C3	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0035JA1	1		
C4	CAP, MICA 270 PF +/-5%, 500V	148452	72136	DM15F271J	REF		
CR1	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	1	1	
H1	WASHER, FLAT, S/S 1/4 INCH (W/P4)	200980	86928	5710-65-16	1		
H2	WASHER, INT LOCK, 1/4 INCH (W/P4)	110817	73734	1308	1		
P2	CONNECTOR, SOCKET, 20 PIN	447110	30035	SK-109-1-20	2		
	CONNECTOR, SOCKET, 16 PIN	447102	20447	SS-109-1-16	1		
P4	BINDING POST	441741	89536	441741	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	1	1	
Q2	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
R1	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R2	RES, DEP CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	2		
R3	RES, DEP CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R4	RES, DEP CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R5	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R6	RES, DEP CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	REF		
R7	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R8	RES, DEP CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	1		
R9	RES, SELECTED AT TEST						
U1	⊗IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	4	1	
U2	⊗IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	2	1	
U3	⊗IC, C-MOS, QUAD, 2-INPUT NAND GATE	404632	02735	CD4093BE	1	1	
U4	⊗IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U5	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	2	1	
U6	⊗IC, COS/MOS, DUAL, 4-INPUT NOR GATES	363820	02735	CD4002AE	1	1	
U7	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U8	⊗IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	02735	CD4011AE	2	1	
U9	⊗IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	02735	CD4011AE	REF		
U10	⊗IC, C-MOS, HEX INVERTER BUFFERS	381848	02735	CD4049AE	1	1	
U11	⊗IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U12	⊗IC, C-MOS, TRIPLE 3-INPUT AND GATES	408807	02735	CD4073BE	1	1	
U13	⊗IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U14	⊗IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U16	⊗IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U17	⊗IC, C-MOS, TRIPLE 3-INPUT NOR GATES	355180	02735	CD4025AE	1	1	



MIS-1674

Figure 605-3. IEEE-488-1975 Piggyback PCB Assembly

Option —08 Isolator

608-1. INTRODUCTION

608-2. When an i/o interface (Options -05, -06, or -07) is installed, the Isolator must be installed to maintain the guarded nature of the analog bus. The module serially isolates the analog signal processing and conversion from the digital processing, control display, and input/output. The maximum allowable difference in potential between guard and logic common is 1000 volts.

608-3. INSTALLATION

608-4. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing a module. The isolator should replace the Interconnect pcb. The interconnect diagram in Section 8 contains a table showing the location of the slot.

608-5. OPERATING NOTES

608-6. Installation of the Isolator does not affect the operation of the instrument.

608-7. THEORY OF OPERATION

608-8. The Isolator accepts parallel data and address bytes, shifts them to serial format for transfer across isolation transformers, and converts them back to parallel format. Seven address lines are used for addressing analog modules with two lines (IC5 and 6) always low. Only one analog module sends data back to the controller: the A/D Converter uses ID7 to form its bit serial data stream. When the Isolator is installed V_{CC} and V_{SS} in the unguarded bus are isolated from analog common. Refer to the schematic, Figure 608-3, for the following discussion.

608-9. Two types of addresses may be sent from the controller to an analog module: a 3-of-7 address accompanied by data used to set up a module or a 2-of-7 indirect address sent to the A/D Converter to obtain a data bit. Address lines IC0-4 are applied through inverters

to shift registers U3 and U7. Module set-up addresses must have one of IC0, 3, or 4 high, which places a low at one input of U10-6. U6-2 goes low, inhibiting U9-11 and enabling U10-8 to go high. All analog module addresses are formed with ones on IC0-4 so IC5 and 6 will be low. U12-11 and U12-3 go high enabling U10-12 to go low. The low going signal from U10-12 clocks a one-shot, U8-4. The consequent low from U8-4 loads data on ID0-7 and the address into U3 and U7. The low from U8-4 also disables a relaxation oscillator, U9-6 and U9-3, which runs at approximately 7.5 MHz. At the end of the load time determined by R2 and C2, U8-4 goes high which enables the oscillator.

608-10. Oscillator pulses from U11-4 and U11-10 clock data serially out of U7 and U3 (from U3-9), through U4 and the isolation transformers (T1, T2, T3, T4) and into U20 and U16. Note that one data input to U3-5 is V_{CC} , which ensures that data bit is high. As data is clocked serially into U20 and U16, U16-11 goes high when data loading is complete. This puts a high on U19-12, disabling the clock pulses from U24-4, and a high on U23-10, clocking U23-12 low, which enables the address gates, U22 and U26-4. Data from U20 and U16 is applied through buffers to the ID lines.

608-11. The low from U23-12 also enables U19-1 so that when the ACK is returned, U25-6 goes low and U19-1 goes high. U19-1 high enables a clock pulse from U24-4 and U24-12 to be applied through U15-3, U15-6, T8, and T7 to clock U8-10, resulting in an ACK signal from U8-12 through U5-6 and Q1.

608-12. In the case of indirect address, IC1, 2, U9-11 is no longer disabled. The above sequence of address and data transfer takes place. Of course there is no data to be sent to the A/D Converter; instead the controller is requesting data to be sent on ID7. Outputs from the address gates, U22 and U26-4, are decoded by U25-9 and U18-4 to cause a high at U18-3. This places U21-13 in the high impedance mode and enables U19-4 through U25-10. The data bit

returned on ID7 is applied through U26-3 and U19-4 to enable U15-8 and U15-11. A clock pulse from U24-4 and U24-12 through U15-11, U15-8, T6, and T5 clocks U14-5. This places a high at U13-10 (provided ID7 is high). U13-9 is enabled by U9-11 through U12-10 and U12-4. If ID7 is low, U19-4 does not go high.

608-13. During the load period (a low from U8-4), the clock (U9-3, U9-6) is disabled. Clock pulses from U24-4 are applied to a retriggerable monostable multivibrator, U23-13. When the clock pulses are disabled, U23-13 places a low on U20-9 and U16-9 to clear any previously latched data.

608-14. TROUBLESHOOTING

608-15. Figure 608-1 gives a symptom analysis approach to troubleshooting the Isolator module.

608-16. PARTS LIST

608-17. Table 608-1 gives a parts breakdown for the Isolator module. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

Figure 608-1. Isolator Troubleshooting

SYMPTOM	POSSIBLE FAILURE
No Display at Power On	IC line held low U5, U12
Display Bad	IC line held high U5, U12 ID line held high or low U1, U2, U13
UNGUARDED SECTION	
Error 9 at Power On	Oscillator check U11 – 10 Shift Register U13 – 1, U7 Not transferring pulses U4, core windings ACK bad U9, U5, Q1, U6, U7
Option Configuration Wrong	Address lines hung
Can't Call Proper Ranges	Data lines hung U1, U2, U3
Constant Bad Reading Displayed	ID7 not returned U14, U13, core winding U12, U10, U9
GUARDED SECTION	
Error 9 or Configuration Wrong	U19 – 10, U16 – 1, U23 – 13 (Address, Data) U25, U19, U15, U24 (ACK) U24, U23 (Address)
Can't Call Proper Ranges	U16, U21, U18
Constant Bad Reading Displayed	U18, U26, U25, U19, U15 (ID7)

Table 608-1. MIS-4181 Isolator Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
⊗	ISOLATOR ASSEMBLY Figure: 608-2	383877	89536	383877	REF		
C1, C4	Cap, mica, 220 pF $\pm 5\%$, 500V	170423	72136	DM15F220J	2		
C2	Cap, mica, 18 pF $\pm 5\%$, 500V	266585	72136	DM15C180J	1		
C3	Cap, mica, 180 pF $\pm 5\%$, 500V	148460	72136	DM15F181J	1		
C5	Cap, mica, 68 pF $\pm 5\%$, 500V	148510	72136	DM15F680J	1		
C6	Cap, Ta, 39 uF $\pm 20\%$, 6V	163915	56289	196D396X0006 KA1	1		
C7	Cap, elect, 150 uF $-10/+50\%$, 16V	186296	73445	ET151X016A5	1	1	
C8, C9	Cap, mica, 27 pF $\pm 5\%$, 500V	177998	72136	DM15E270J	2		
C10, C12, C13	Cap, cer, 0.22 uF $\pm 20\%$, 50V	309849	71590	CW30C224K	3		
C11	Cap, cer, 4700 pF $\pm 10\%$, 500V	106724	71590	CF472	1		
Q1	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
R1	Res, comp, 220 $\pm 5\%$, 1/4W	147959	01121	CB2215	1		
R2, R5, R8 thru R13	Res, comp, 10k $\pm 5\%$, 1/4W	148106	01121	CB1035	8		
R3	Res, comp, 47k $\pm 5\%$, 1/4W	148163	01121	CB4735	1		
R4, R7	Res, comp, 4.7k $\pm 5\%$, 1/4W	148072	01121	CB4725	2		
R6	Res, comp, 1k $\pm 5\%$, 1/4W	148032	01121	CB1025	1		
R14	Res, comp, 150 $\pm 5\%$, 1/4W	147934	01121	CB1515	1		
R15	Res, comp, 470 $\pm 5\%$, 1/4W	147983	01121	CB4715	1		
T1, T3, T6, T8	Inductor	437608	89536	437608	4		
T2, T4, T5, T7	Inductor	437590	89536	437590	4		
U1, U2, U5	⊗ IC, Dgtl, C-MOS, hex, buffer/inverter	381830	02735	CD4050AE	3	1	
U3, U7	IC, TTL, MSI, 8-bit shift register	293118	01295	SN74165N	2	1	
U4, U15	IC, Dgtl, TTL, quad, 2-input, hi-vol, NAND	408021	01295	SN7426N	2	1	

Table 608-1. MIS-4181 Isolator Assembly (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U6, U24	⊗ IC, Dgtl, TTL, hex inverter	393058	01295	SN74LS04N	2	1	
U8, U14, U23	⊗ IC, Dgtl, TTL, lo-pwr	404186	01295	SN74LS123N	3	1	
U9	⊗ IC, Dgtl, TTL, quad 2-input, NAND gate	363580	01295	SN74S00N	1	1	
U10	⊗ IC, Dgtl, TTL, triple, input, POS NAND gates	393074	01295	SN74LS10N	1	1	
U11, U19	⊗ IC, Dgtl, POS NOR gates, w/totempole output	393041	01295	SN74LS02N	2	1	
U12, U22, U26	⊗ IC, Dgtl, COS/MOS, NOR gates	355172	02735	CD4001AE	3	1	
U13, U21	⊗ IC, Dgtl, C-MOS, tri-state, hex, non-inverting buffers	407759	12040	MM80C97N	2	1	
U16, U20	IC, TTL, 8-bit serial-in parallel-out, shift register	272138	01295	SN74164N	2	1	
U17	Res Network, 10k, 16 pin	355305	89536	355305	1	1	
U18	⊗ IC, Dgtl, C-MOS, quad, 2-input AND gate	408401	02735	CD4081BE	1	1	
U25	⊗ IC, C-MOS, NOR gates	355180	02735	CD4025AE	1	1	
	Case half, module	402990	89536	402990	2		
	Cover, module case	402974	89536	402974	1		
	Decal Isolator	413534	89536	413534	1		
	Guard, front, left	437921	89536	437921	1		
	Guard, front, right	401513	89536	401513	1		
	Guard, rear, left	437947	89536	437947	1		
	Guard, rear, right	383349	89536	383349	1		
	Shield, cover	437939	89536	437939	2		

NOTES:

1. FOR ASSY DRAWING SEE M.I.S. - 4181
2. FOR PCB SEE M.I.S. - 3181
3. FOR SCHEMATIC SEE M.I.S. - 1181

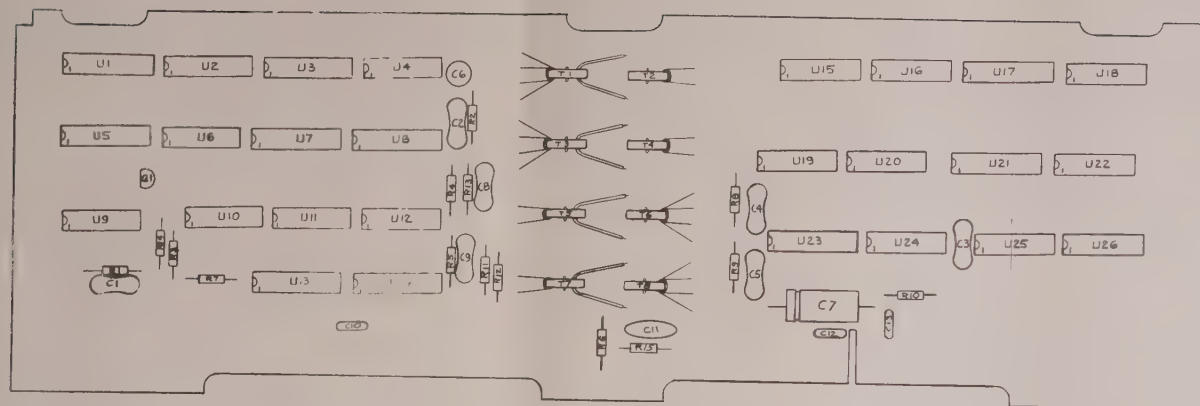


Figure 608-2. Isolator Assembly (M.I.S.-1781)

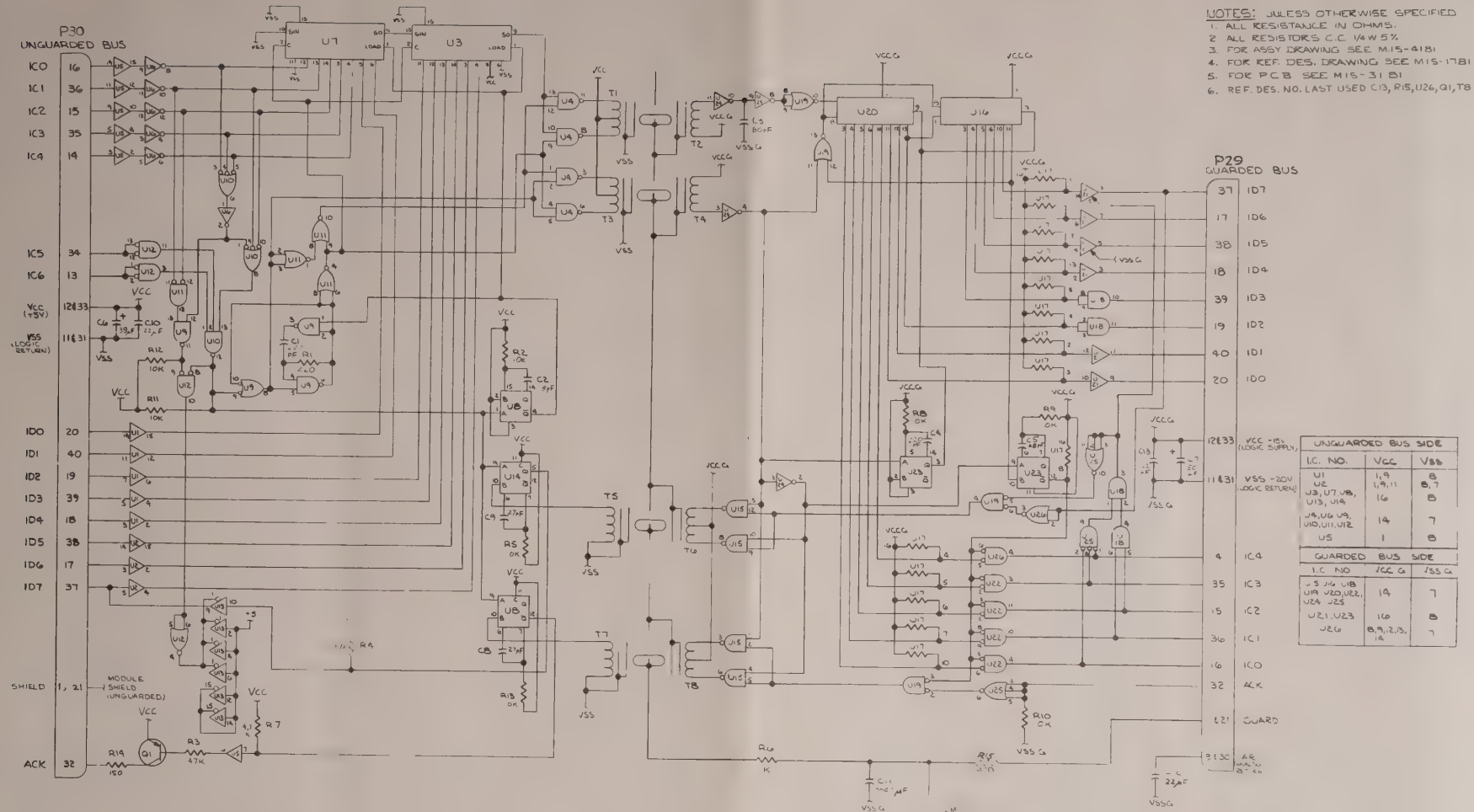


Figure 608-3. Isolator (M.I.S.-1181)

Isolator -08A (External Trigger)

608A-1. INTRODUCTION

608A-2. The Isolator module maintains the guarded nature of the analog bus by isolating the analog signal processing and converting circuitry from the digital processing, control, display, and input/output circuits. An Isolator module must be installed whenever a remote interface (option -05, -06, or -07) is used in an 8500 series DMM. The following description pertains to the Isolator -08A only. This module provides the capability for external triggering of the DMM. The 8500A DMM does not have provision for external triggering and consequently must use the -08 Isolator or the -08A without external triggering.

608A-3. INSTALLATION

608A-4. Refer to Section 4 of the Instruction Manual for general module installation procedures. The Isolator module uses slot K (which can be identified as the only module slot with connectors on both the analog and digital bus lines). Section 8 contains further information on module slot locations.

608A-5. SPECIFICATIONS

608A-6. Input

608A-7. The trigger input is factory-wired for a high level of 4.3V (minimum) and a low level of 0.7V (maximum); pulse width should be greater than 10 μ s. Common will be the same as interface logic common.

608A-8. The outer connector for external triggering is at interface common. There should be no more than 10V between the outer connector and earth ground.

608A-9. Trigger Processing Time

608A-10. The time between trigger edge and first A/D conversion (not including filter timeouts or programmed delays) is:

1. Non-line synchronous mode, .8 to .9 ms
2. Line synchronous mode, 1 to 6 ms
3. High speed mode (Option -05 or -07 installed), $114 \pm .5 \mu$ s

608A-11. OPERATING NOTES

608A-12. Installation of the Isolator (Option -08A) will not affect standard operation of the instrument. The External Triggering mode may, however, be activated locally from the front panel or through remote interfacing commands.

608A-13. Local Operation

608A-14. The External Triggering mode may be enabled from the DMM's front panel (Option -08A must be installed). To activate this mode, press TRIGGER. The SAMPLE LED will now stop flashing to denote that both External Triggering and Manual Triggering modes are in effect. Apply a negative going TTL level pulse to the external trigger input connector located on the rear panel. The SAMPLE LED will now flash once for each trigger received.

608A-15. The following considerations apply when External Triggering mode is in use:

1. A manual trigger attempted from the front panel will take precedence over an external trigger. If manual TRIGGER is pressed while a reading is in progress, the reading will be aborted and a new one started.
2. All other front panel switch applications will abort the reading in progress. A new reading

will not start until another trigger is received; the numeric display will not update until the new reading is complete.

608A-16. Remote Operation

608A-17. External Triggering can be enabled and controlled remotely when a remote interface (Option -05, -06, or -07) and the Isolator (Option -08A) are installed. The command characters in Table 608A-1 can be used from the remote.

608A-18. Trigger Polarity

608A-19. Either positive or negative going external triggers may be accepted by the Isolator (Option -08A); factory settings will be for negative triggers. Separate jumper wire arrangements are employed for negative and positive triggers. Refer to Figure 608A-1 for the location of jumper terminals on the Isolator PCB. To change the jumper arrangement, use the following procedure:

1. On the Digital Multimeter (8500 series), press POWER OFF and disconnect the line cord.

Table 608A-1. Remote Commands

Ext. Trigger Commands	
Q	Ext. Trigger—interrupt when ready
Q1	Ext. Trigger and Transmit Reading
Q0	Disable Ext. Trigger
External Trigger Delay Commands	
W	No Delay
W0	2.083 ms
W1	4.166 ms
W2	8.332 ms
W3	16.66 ms
W4	33.33 ms
W5	66.66 ms
W6	133.3 ms
W7	266.6 ms
W8	533.2 ms
W9	1,066s
W10	2.133s
W11	4.266s
W12	8.532s
W13	17.06s
W14	34.13s
W15	68.26s

2. Remove the Isolator module.
3. Observe Static Sensitive device precautions listed in Section 4 of the Instruction Manual. Avoid touching connector terminals on the Isolator PCB.
4. Remove the Guard Covers from the Isolator PCB using techniques outlined in Section 4 of the Instruction Manual (Module Assembly and Disassembly).
5. For negative going triggers, there will be a jumper between pin 1 and pin 4 on Schmitt Trigger U35.
6. For positive going triggers, remove the jumper between pins 1 and 4 and jumper pin 1 to 2 and 3 to 4 on U35.
7. Reassemble module, replace in Digital Multimeter.

608A-20. THEORY OF OPERATION

608A-21. The Isolator accepts parallel data and address bytes, shifts them to serial format for transfer across isolation transformers, and converts them back to parallel format. Seven address (ID) and eight data (ID) lines are used. Lines IC5 and IC6 are always low. The

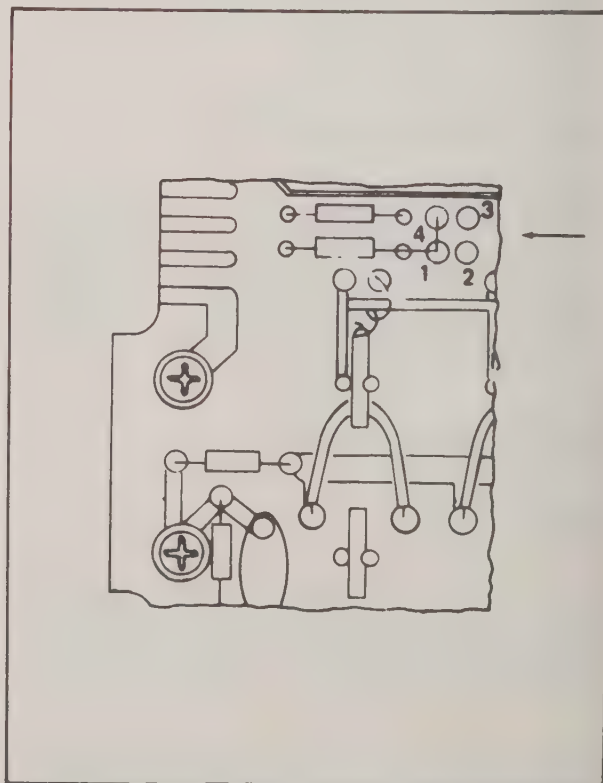


Figure 608A-1. Trigger Polarity Connections

Controller can send data to any addressed module; the A/D Converter will be the only analog module that sends data back to the Controller (bit serial data stream on ID7). Refer to the Isolator Schematic (Figure 608A-3) and the Functional Block Diagram (Figure 608A-2) for the following circuit descriptions.

NOTE

When the Isolator is Installed, V_{cc} and V_{ss} in the unguarded digital bus are isolated from analog common.

608A-22. The description given in this paragraph will detail how data (ID0-ID7) and address (IC0-IC4) levels on the unguarded digital bus are loaded into shift registers (U3 and U7) in the Isolator. Inputs on address lines IC0-4 for either direct or indirect addresses are applied through inverters to shift register U7. Inputs on data lines (ID0-7) are applied to U7 (ID0, ID1) and U3 (ID2-7). A low on U14-12 will clock both address and data levels into the shift registers; the relaxation oscillator made up of U9-6 and U9-8 will be disabled by this same low during the load time. Monostable multivibrator U14-12 is clocked by a low going signal on U10-12. Two inputs to U10-12 will always be high (IC5, IC6 will always be low and are inverted). The third input will be a high from U10-8, which is enabled with any direct address on IC0-4 (IC0, 3, or 4 will have at least one high). The length of the load time will be determined by R2 and C2.

608A-23. At the end of the load time, relaxation oscillator U9-6 and U9-8 will be enabled, and data will be serially shifted out of registers U3 and U7, across isolation transformers T1 and T2, and into registers U20 and U6. Oscillator pulses from U11-10 and U11-13 clock serial data out of U3 and U7, and into U20 and U16. When this data transfer is complete, U16-11 will go high to enable address gates U22 and U26-4 and disable loading clock pulses to U20 and U16. Parallel data will then be applied through output buffers to ID0-7 on the guarded analog bus. Parallel address levels will be applied through the enabled address gates to address lines IC0-4 on the guarded analog bus.

608A-24. The clock pulse for U9-6 and U9-8 is disabled during the load period (U14-12 low). When clock pulses cease from U24-4, retriggerable monostable multivibrator U23-13 places a low on U20-9 and U16-9 to clear any previously latched data.

608A-25. An acknowledge (ACK) signal is transferred from the guarded analog bus to the unguarded digital bus by way of an isolation transformer. A low at U23-12 will enable U19-1 whenever an ACK is returned. With U19-1 high, a clock pulse from U24-4 and U24-12 is applied through U15-3, U15-6, T8 and T7. This pulse then clocks U8-2, resulting in an ACK signal out on U8-13.

608A-26. In order to obtain a data bit return on ID7, the indirect address is used in three ways. First, the address (IC1, IC2 high) is sent to the A/D Converter

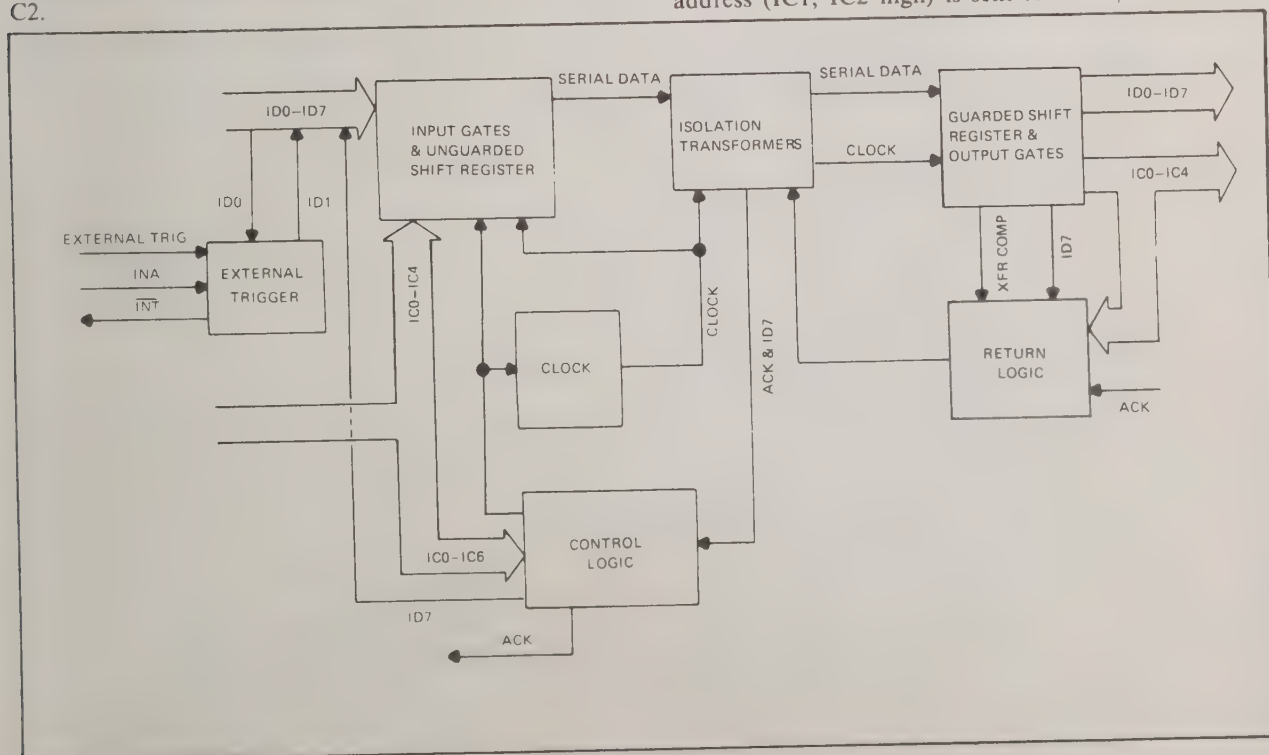


Figure 608A-2. Isolator Block Diagram

through the Isolator's shift register system. The address will also be used to enable U9-11 on the unguarded side of the Isolator. Thirdly, on the Isolator's guarded side, IC1 and IC2 high will enable address decoders U18-4 and U25-9. With U18-3 consequently high, tri-state device U21-13 is placed in the high impedance mode. A path is now enabled for ID7 levels from the guarded analog bus to be transferred back to the unguarded digital bus. For instance, with a high on U19-5, ID7 high will enable U19-4. Clock pulses from U24-4 and U19-4 high enable U15-11 and U15-8. While U9-11 enables U13-9, U8-5 clocked high places ID7 high on the unguarded digital bus.

608A-27. The following sequence of events takes place in the Isolator during external triggering. Dual D flip-flop U31 will be enabled by a low on ID0 and high at U33-9. Address lines IC4, IC5, and IC6 must all be high for U33-9 to go low. With Vcc applied to U31-5, a positive going external trigger from U35-10 will clock U31-1 high. The network of R24 and C6 will detect Vcc at power on

and disable the module's interrupt capability. The high at U31-1 sets INT low and places a high at pin 12 of tri-state buffer U13. A returned high on INA then gates U13-11 high onto ID1. The controller will react to this high on ID1 by taking a reading. When data from the reading is accepted, ID0 will again go low, resetting U31 ready for the next external trigger. Triggers received prior to ID0 going low will be ignored.

608A-28. TROUBLESHOOTING

608A-29. Table 608A-2 gives a symptom analysis routine for troubleshooting the Isolator module.

608A-30. PARTS LIST

608A-31. Table 608A-3 gives a detailed parts breakdown of the Isolator (Option -08A). Refer to Section 5 of the Instruction Manual for ordering information.

Table 608A-2. Isolator Troubleshooting

SYMPTOM	POSSIBLE FAILURE
No display at Power On	IC line held low U5, U12, U35
Display Bad	IC line held high U5, U12, U35
	ID line held high or low U1, U2, U13
UNGUARDED SECTION	
Error 9 at Power On	Oscillator check U11-10 Shift Register U31-1, U7 Not transferring pulses U4, core windings ACK bad U9, U12, Q1, U6, U7, U2, U8
Option Configuration Wrong	Address lines hung
Can't Call Proper Ranges	Data lines hung U1, U2, U3
Constant Bad Reading Displayed	ID7 not returned U8, U13, core winding U12, U10, U9, U35, U6.
GUARDED SECTION	
Error 9 or Configuration Wrong	U19-10, U16-1, U23-13 (Address, Data) U25, U19, U15, U24 (ACK) U24, U23 (Address)
Can't Call Proper Ranges	U16, U21, U18
Constant Bad Reading Displayed	U18, U26, U25, U19, U15 (ID7)

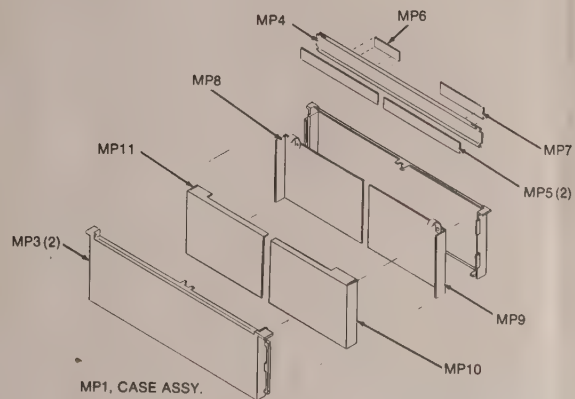
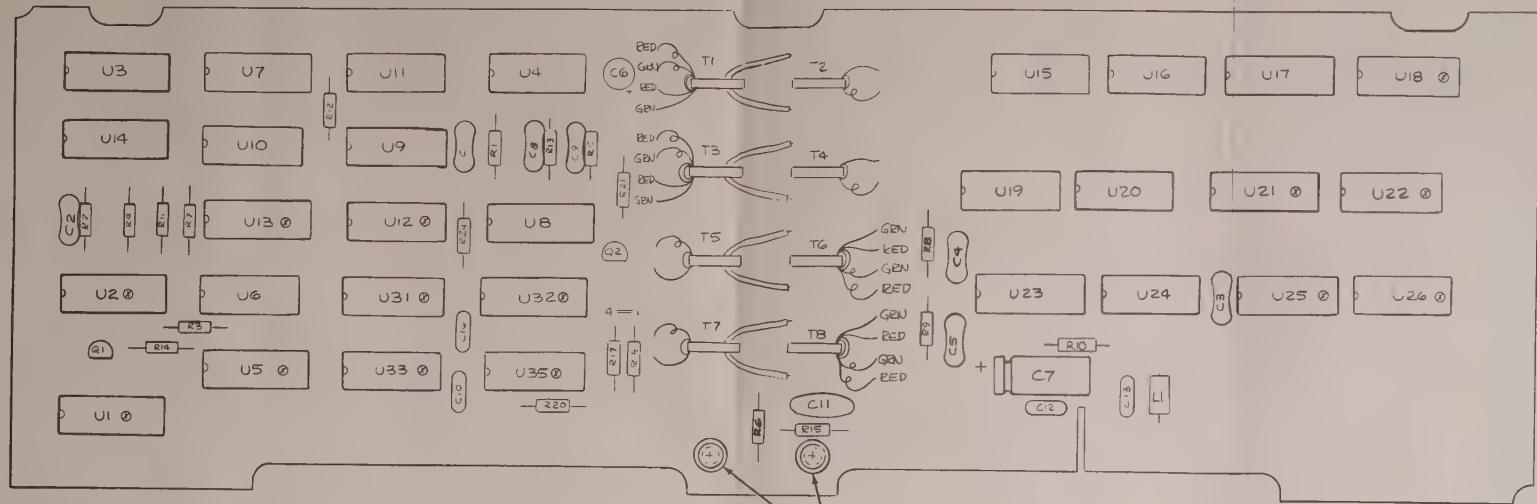
Table 608A-3. Isolator PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	N O T E
-08A	ISOLATOR PCB ASSEMBLY FIGURE 608A-3 (8502A-4181T)	ORDER	BY	OPTION -08A			
C1	CAP, MICA, 220 PF +/-5%, 500V	170423	72136	DM15F221J	2		
C2	CAP, MICA, 18 PF +/-5%, 500V	266585	72136	DM15C180J	1		
C3	CAP, MICA, 180 PF +/-5%, 500V	148460	72136	DM15F181J	1		
C4	CAP, MICA, 220 PF +/-5%, 500V	170423	72136	DM15F221J	REF		
C5	CAP, MICA, 68 PF +/-5%, 500V	148510	72136	DM15F680J	1		
C6	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006KA1	1		
C7	CAP, ELECT, 150 UF -10/+50%, 16V	186296	73445	ET151X016A5	1		
C8, C9	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15E270J	2		
C10	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	4		
C11	CAP, CER, 0.0047 UF +/-10%, 500V	106724	71590	CF-472	1		
C12, C13	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C16	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
H1	SCREW, PHP, 4-40 X 5/8	145813	73734	19027	2		
L1	INDUCTOR, COIL 6-TURN	320911	89536	320911	1		
MP1	CASE MODULE ASSY (INCLUDES MP2-MP11)	486407	89536	486407	1		1
MP2	CASE HALF, MODULE	402990	89536	402990	REF		
MP3	CASE HALF, MODULE	402990	89536	402990	REF		
MP4	COVER, MODULE, CASE	486340	89536	486340	REF		
MP5	SHIELD, COVER	437939	89536	437939	REF		
MP6	DECAL, ISOLATOR/EXT TRIGGER	477570	89536	477570	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR LEFT	437947	89536	437947	REF		
MP9	GUARD, REAR RIGHT	383349	89536	383349	REF		
MP10	GUARD, FRONT LEFT	487298	89536	487298	REF		
MP11	GUARD, FRONT RIGHT	487280	89536	487280	REF		
MP12	SPRING, COIL (not shown)	424465	83553	C0120-014-0380	2		
Q1	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1		1
Q2	TRANSISTOR, SI, NPN	218396	04713	2N3904	1		1
R1	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P 220ET	1		
R2	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	9		
R3	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47KT	2		
R4	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P 4K7T	2		
R5	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R6	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1KT	2		
R7	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P 4K7T	REF		
R8-R13	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R14	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R15	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P 470ET	1		
R17	RES, DEP. CAR, 10K +/-5%, 1/4W	343426	80031	CR251-4-5P1KT	2		
R18	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
R20	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R21	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47KT	2		
R24	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
T1	INDUCTOR	437608	89536	437608	4		
T2	INDUCTOR	437590	89536	437590	4		
T3	INDUCTOR	437608	89536	437608	REF		

Table 608A-3. Isolator PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
T4	INDUCTOR	437590	89536	437590	REF		
T5	INDUCTOR	437590	89536	437590	REF		
T6	INDUCTOR	437608	89536	437608	REF		
T7	INDUCTOR	437590	89536	437590	REF		
T8	INDUCTOR	437608	89536	437608	REF		
U1	⊗ IC, C-MOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE	3	1	
U2	⊗ IC, C-MOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE	REF		
U3	IC, TTL, MSI 8 BIT SHIFT REGISTER	293118	01295	SN74165N	2	1	
U4	IC, TTL, QUAD, 2INPUT HV INTRF NAND	408021	18324	N7426A	2	1	
U5	⊗ IC, C-MOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE	REF		
U6	IC, TTL, POS NAND GATES, HEX INVERTERS	393058	01295	SN74LS04N	2	1	
U7	IC, TTL, MSI 8-BIT SHIFT REGISTER	293118	01295	SN74165N	REF		
U8	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	3	1	
U9	IC, TTL, QUAD 2-INPUT NAND GATE	363580	01295	SN7400SN	1	1	
U10	IC, POS NAND GATES, TRIPLE 3 INPUT	393074	01295	SN74LS10N	1	1	
U11	IC, POS NOR GATES, TOTEM POLE OUTPUTS	393041	01295	SN74LS02N	2	1	
U12	⊗ IC, C-MOS, QUAD 2-INPUT NOR GATES	355172	02735	CD4001AE	1		
U13	⊗ IC, C-MOS, TRI-STATE HEX NONINV BUFFERS	407759	12040	MM80C97N	2	1	
U14	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	REF		
U15	IC, TTL, QUAD, 2INPUT HV INTRF NAND	408021	18324	N7426A	REF		
U16	IC, SHIFT REGISTER, 8 BIT PARALLEL OUT	272138	01295	SN74164N	2	1	
U17	RES NETWORK, 10K +/-5%, 1/4W	355305	89536	355305	1	1	
U18	⊗ IC, C-MOS, QUAD 2-INPUT AND GATES	408401	02735	CD4081B1	1	1	
U19	IC, POS NOR GATES, TOTEM POLE OUTPUTS	393041	01295	SN74LS02N	REF		
U20	IC, SHIFT REGISTER, 8 BIT PARALLEL OUT	272138	01295	SN74164N	REF		
U21	⊗ IC, C-MOS, TRI-STATE HEX NONINV BUFFERS	407759	12040	MM80C97N	REF		
U22	⊗ IC, C-MOS, QUAD 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U23	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	REF		
U24	IC, TTL, POS NAND GATES, HEX INVERTERS	393058	01295	SN74LS04N	REF		
U25	⊗ IC, C-MOS, TRIPLE 3-INPUT NOR GATES	355180	02735	CD4025AE	1	1	
U26	⊗ IC, C-MOS, QUAD 2-INPUT NOR GATES	355172	02735	CD4001AE	1	1	
U31	⊗ IC, C-MOS, DUAL "D" FLIP FLOP	340117	04713	MC14013CP	1	1	
U32	⊗ IC, C-MOS, FAST QUAD 2-INPUT NAND GATE	413211	12040	34011PC/4011PC	1	1	
U33	⊗ IC, C-MOS, TRIPLE 3-INPUT NAND GAE	375147	04713	MC14023CP	1	1	
U35	⊗ IC, C-MOS, HEX SCHMITT TRIGGER	477810	12040	MM74C914N	1	1	

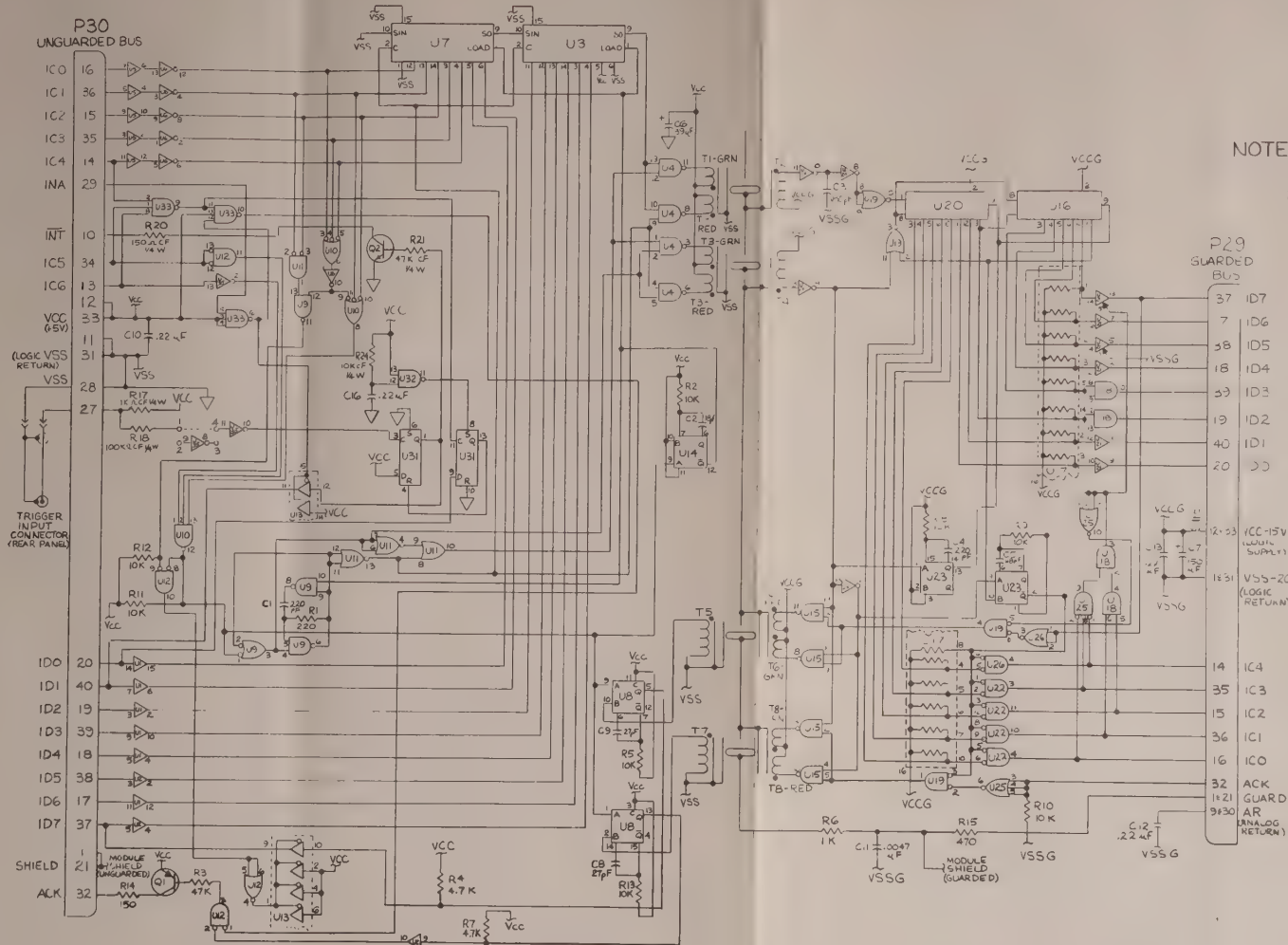
1 ORDER P/N 486407 FOR COMPLETE
MODULE CASE ASSY., WITHOUT PCB ASSY.



8502A-4181-CASE

8502A-1781

Figure 608A-3. Isolator PCB Assembly



NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTANCE IN OHMS.
2. ALL RESISTORS C.C. 14 W 5%.

UNGUARDED BUS SIDE			
NO.	VCC	VSS	
1	5	7	
2	1	7	
3	16	2	
4	14	7	
5	14	7	
6	14	7	
GUARDED BUS SIDE			
NO.	VCC	VSS	
14	14	7	
15	14	7	
16	14	7	
17	14	7	
18	14	7	
19	14	7	
20	14	7	
21	14	7	
22	14	7	
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93	14	7	
94	14	7	
95	14	7	
96	14	7	
97	14	7	
98	14	7	
99	14	7	
100	14	7	

Figure 608A-3. Isolator PCB Assembly (cont)

Option —09 AC/DC Converter (RMS)

609-1. INTRODUCTION

609-2. The AC/DC Converter (RMS) is used to provide accurate ac or ac + dc measurements without error due to waveform distortion. Measurements up to 1000 Vac in four ranges with a bandwidth of 10 Hz to 300 kHz may be made (input volt-hertz product not to exceed 2×10^7). Input impedance is $1 \text{ M}\Omega$ shunted by less than 100 pf.

609-3. SPECIFICATIONS

609-4. Table 609-1 lists the specifications for the true RMS Converter.

609-5. INSTALLATION

609-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing the AC/DC Converter (RMS) module. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

609-7. OPERATING NOTES

609-8. Operation of the front panel controls is the same as described in Section 2. An ac voltage on a dc level may be measured by depressing both the Vdc and the Vac function switches at the same time. The reading displayed will be the rms value of the two voltages combined. External reference inputs at the rear panel must be dc voltages only. The slow filter (FILTER LED illuminated) must be selected for full accuracy below 400 Hz.

609-9. THEORY OF OPERATION

609-10. The function of the RMS Converter is to accept signals from either the input terminals or the optional

Current Shunts module and to convert the input signal to a dc level proportional to the rms value of the input. The dc output from the RMS Converter is routed on the Guarded Bus to the Active Filter module and then to the A/D Converter. True rms conversion is mathematically obtained by averaging the squared value of the input, then taking the square root ($V_{\text{rms}} = \sqrt{\overline{V_{\text{in}}^2}}$). Limitations to the realization of this mathematical formula using operational techniques are crest factor (ratio of peak value to rms value, limited by the dynamic range of the amplifiers), frequency response, and accuracy.

609-11. Input signals are applied to the Range Amplifier (Q1, U3) to be brought within the $1V_{\text{rms}}$ range. Refer to Figure 609-1. Before a signal can be operationally squared, it must be converted to an absolute value. Balance Amplifier (U4, Q10) performs this function by inverting and rectifying the signal from U3. Outputs from the Range Amplifier and the Balance Amplifier are applied through R33 and R31 to the summing node of the Squaring Amplifier (U5, Q11). Due to the ratio of R33 to R31, the inverted negative half-cycles from the Balance Amplifier are twice the amplitude of the negative half-cycles from the Range Amplifier. When summed, the waveform is the absolute value of the output from the Range Amplifier. The conversion to rms is performed by the Squaring Amplifier, Integrator, and Square Root Amplifier. Implementation of these functions depends on the logarithmic response of PN junctions. Since two PN junctions are used in each of two parts of a feedback loop, a double logarithmic response is generated ($2 \log X = \log X^2$). The Squaring Amplifier converts the signal to a current flowing through the emitters of two transistors, Q8A and Q12A. These two transistors are configured with two additional transistors, Q12B and Q8B, in a feedback loop which constrains the output voltage to be the square root of the integral of the square of the current flowing in Q8A and Q12A.

Table 609-1. AC/DC Converter (RMS) Specifications

ACCURACY									
(Refer to Section 1 for required environmental conditions)									
Accuracy (0.1% of Range to Full Scale)									
Frequency	24 Hours			90 Days			1 Year		
	% of Input	+% FS AC	+% FS AC + DC	% of Input	+% FS AC	+% FS AC + DC	% of Input	+% FS AC	+% FS AC + DC
DC	0.075	—	0.03	0.1	—	0.03	0.2	—	0.06
10 Hz to 20 Hz	0.75	0.04	0.06	1.0	0.04	0.06	2.0	0.08	0.12
20 Hz to 50 Hz	0.35	0.012	0.03	0.5	0.012	0.03	1.0	0.04	0.06
50 Hz to 10 kHz	0.075	0.012	0.03	0.1	0.012	0.03	0.2	0.04	0.06
10 kHz to 30 kHz	0.15	0.04	0.06	0.2	0.04	0.06	0.4	0.08	0.12
30 kHz to 50 kHz	0.2	0.1	0.12	0.3	0.1	0.12	0.6	0.6	0.25
50 kHz to 100 kHz	0.75	0.3	0.3	1.0	0.3	0.3	2.0	0.6	0.6
100 kHz to 300 kHz	1.5	0.5	0.5	2.0	0.5	0.5	4.0	1.0	1.0
NOTES: 1. Slow Filter must be used for full accuracy below 400 Hz. 2. Volt-Hertz product not to exceed 2×10^7 3. For inputs above 500V, multiply accuracy by: $\left(\frac{2000V + V_{in}}{2000V}\right)$									

INSTRUMENT OPERATING CHARACTERISTICS									
INPUT CHARACTERISTICS					SETTLING TIME (To within 0.1%)				
Range	Full Scale	Resolution		Impedance	100 ms, Fast Filter 500 ms, Slow Filter				
		Normal	High						
1V	2.5V	10 μ V	1 μ V	1 M Ω , <100 pF	COMMON MODE REJECTION (100 Ω Unbalance) 120 dB, dc to 60 Hz				
10V	20V	100 μ V	10 μ V						
100V	160V	1 mV	100 μ V						
1000V	1000V	10 mV	1 mV						
MAXIMUM INPUT 1000V rms of 2×10^7 volt-hertz product, whichever is less.					CREST FACTOR >7 at full scale, increasing down scale by: $7 \times \sqrt{\frac{V_{Range}}{V_{Input}}}$				
TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C) AC* Only $\pm(40 \text{ ppm or Reading} + 20 \text{ ppm f.s.})/^{\circ}\text{C}$ AC* + DC $\pm(40 \text{ ppm of Reading} + 40 \text{ ppm f.s.})/^{\circ}\text{C}$ *Frequencies <10 kHz					DIGITIZING Same as dc volts				

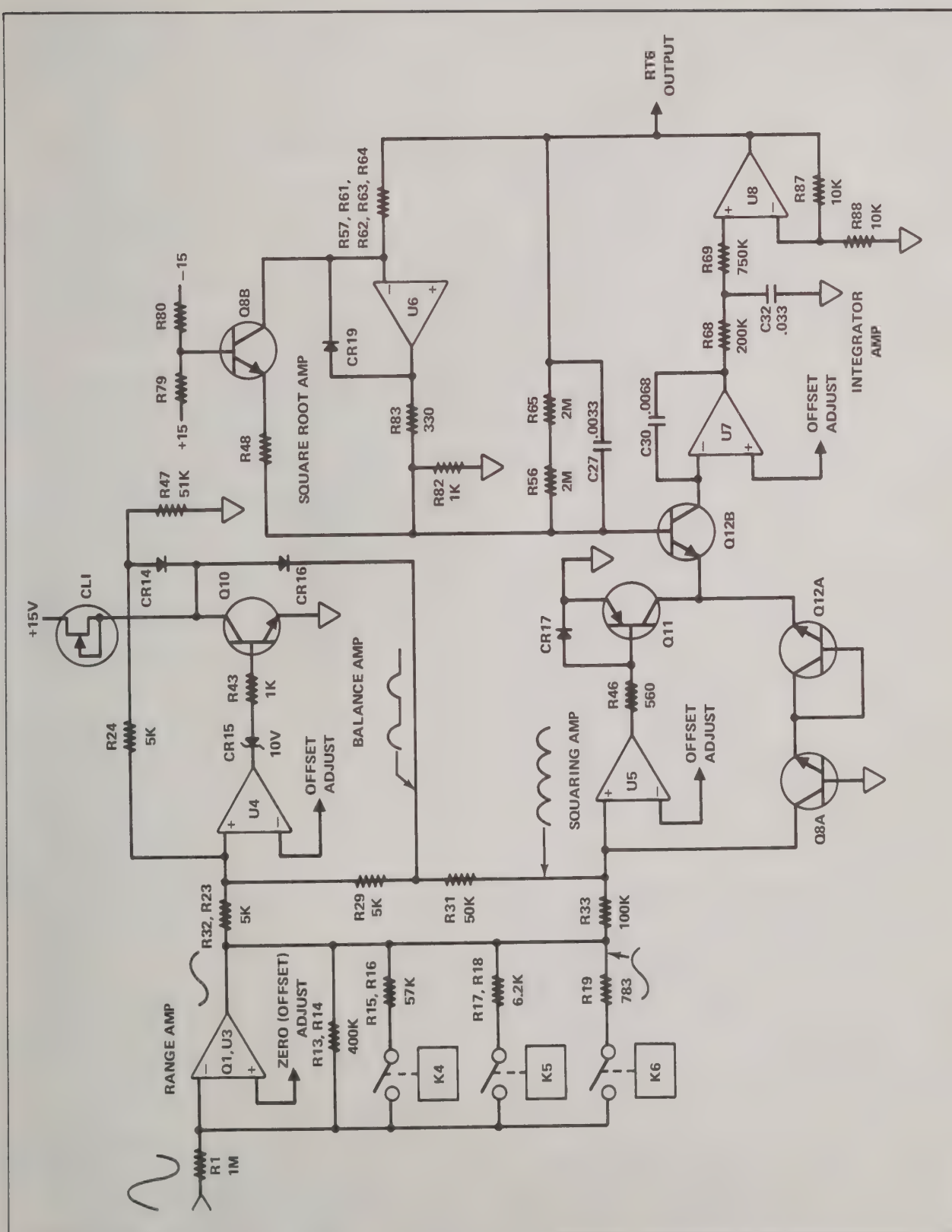


Figure 609-1. AC/DC Converter (RMS)

609-12. Circuit Description

609-13. Refer to the schematic for the following discussion.

609-14. RANGE AMPLIFIER

609-15. The Range Amplifier is an inverting amplifier with gain control provided by switching feedback impedances. Feedback impedances are controlled by relays K4, K5, or K6, and consist of parallel resistors and capacitors adjusted for proper gain and frequency response. Relays K1, K2, and K7 control the input to the amplifier. K1 is energized for inputs from the input terminals. K7 is energized for inputs from the Current Shunts module. K2 is energized when selecting ac + dc measurements. Gain of the amplifier is set for a 1V rms output with a full-scale sine wave input with the exception of the 1000V range in which the full-scale output is .8V rms. Q1 and U3 provide the forward gain of the amplifier. CR6, CR7, CR21, and CR22 provide input protection. Q2 drives the guard for the summing node of the operational amplifier.

609-16. BALANCE AMPLIFIER

609-17. The Balance Amplifier is an inverting, unity-gain amplifier with diodes in the feedback paths to provide rectification. CL1 and Q10 are configured as a current source driven by U4. A high impedance current source is used to minimize the effects of the diodes on the gain of the amplifier. Due to the unity gain of the inverting amplifier and the ratio of R33 to R31, the negative half-cycles from the Range Amplifier are summed with positive half-cycles having twice the amplitude from the Balance Amplifier. The result is the absolute value of the output from the Range Amplifier. Q6 is used to extend the frequency response of the amplifier.

609-18. COMPUTATION

609-19. The Squaring Amplifier, Square Root Amplifier, and Integrator Amplifier work together to perform the rms conversion. This is accomplished by regulating the current in four transistors, Q8A, Q12A, Q8B, and Q12B, matched for temperature coefficient and response characteristics. The Squaring Amplifier sums the outputs from the Range Amplifier and the Balance Amplifier such that the current flowing through its feedback path (Q8A, Q12A) is proportional to the absolute value of the input signal. Forward gain of the amplifier is provided by U5 and Q11 with Q7 extending the frequency response.

609-20. Q12B is configured such that the integral of its collector current is the output voltage. U7 and U8 integrate the collector current of Q12B. Q8B is configured such that its collector current is proportional to the output voltage. The current through Q8B controls the gain of U6, the Square Root Amplifier, which in turn partially controls the current flowing in Q12B. The integrating time constant

of U7 and U8 is determined by R56 and R65 in parallel with C27 or C27 plus C28, depending on which filter is selected from the front panel. The proportionality constant of the converter is such that a full-scale input produces a 20V output on RT6.

609-21. MAINTENANCE

609-22. Performance Test

609-23. Use the following procedure as a performance determination of the AC/DC Converter (RMS).

1. Select AC Volts and Autoranging.
2. Connect the AC Calibrator system output to the input terminals.
3. Sequentially apply the input voltages and frequencies listed in Table 609-2 and verify that the instrument reading falls within the specified limits.
4. Disconnect the AC Calibrator and connect the DC Calibrator.
5. Select an output from the DC Calibrator of + 10.0000V dc.
6. Verify that the display reads between 9.9840 and 10.0160.
7. Reverse the leads at the output of the DC Calibrator.
8. Verify that the display reads between 9.9840 and 10.0160.

Table 609-2.

INPUT		8500A READING	
FREQ	VOLTAGE	LOW	HIGH
10 kHz	1 V	0.99870	1.00130
50 kHz	1 V	0.99450	1.00550
10 kHz	10 V	9.9876	10.0124
50 kHz	10 V	9.9500	10.0500
10 kHz	100 V	99.881	100.119
50 kHz	100 V	99.540	100.460
10 kHz	1000 V	998.48	1001.52

609-24. Calibration

609-25. Before calibrating the RMS Converter, remove the Calibration Memory and allow a one hour warm-up. After calibration is complete, reinstall the Calibration Memory and enter new values at the zero and cardinal points.

609-26. Use the following procedure to calibrate the RMS Converter. All adjustments are on the AC/DC

Range & F.R. adjustments

Converter (RMS) module. Ensure that the DC Volts function is within tolerance (Section 4).

609-27. RANGE ZERO

1. Connect a test DVM between TP5 (HI) and TP1 (LO) and short the input terminals.
2. Select the 10V range.
3. Adjust R12, Range Zero, for a reading on the test DVM of $0 \pm 30 \mu\text{V}$.
4. Remove the short connecting the input terminals and the test DVM.

609-28. BALANCE ADJUSTMENTS

1. Apply -0.200000V dc to the input terminals from a DC Calibrator. Record the absolute value of the reading.
2. Reverse the polarity of the input to $+0.200000$.
3. Adjust R42 Balance Zero twice as far as required to equal the absolute value recorded in step 1.
4. Repeat steps 1, 2, and 3 until the difference between the absolute values is less than 10 digits without an adjustment.
5. Select the Cal mode of operation, i.e., the CAL switch ON and the CAL indicator illuminated.

NOTE

The Cal mode prevents the instrument from overranging during adjustments at the range upper limit. Ignore the cal digit while making check or adjustments for the remainder of this procedure.

6. Apply -20.00000V dc to the input terminals from a DC Calibrator. Record the absolute value of the reading.
7. Reverse the polarity of the input to $+20.00000$.
8. Adjust R32 Balance Gain to the absolute value recorded in step 6.
9. Repeat steps 6, 7, and 8 until the difference between the absolute values is less than 10 digits without an adjustment.

609-29. ZERO ADJUST

1. Select the VAC function and the IV range.
2. Apply an input of 2.5 mV ac at 500 Hz from the AC Calibrator system.
3. Adjust R45 AC ZERO for a reading between 0.00245 and 0.00255 .

609-30. ACCURACY TESTS

1. Select the 1000V range.
2. Apply an input of 500V ac at 500 Hz from the AC Calibrator system.
3. Adjust R64 for a reading between 499.990 and 500.010 .
4. Increase the input frequency to 50 kHz .
5. Adjust C4 for a reading between 499.990 and 500.010 .
6. Apply an input of 2.5V ac at 500 Hz from the AC Calibrator system.
7. Select the IV range.
8. Adjust R14 for a reading between 2.49975 and 2.50025 .
9. Increase the input frequency to 50 kHz .
10. Adjust C9 for a reading between 2.49975 and 2.50025 .
11. Verify that the values given in steps 1 through 8 of Table 609-3 are within the stated tolerances for the voltage and frequency listed.
12. Select the 10V range.
13. Apply an input of 20V ac at 500 Hz from the AC Calibrator system.
14. Adjust R16 for a reading between 19.9980 and 20.0020 .
15. Increase the input frequency to 50 kHz .
16. Adjust C11 for a reading between 19.9980 and 20.0020 .
17. Select the 100V range.
18. Apply an input of 160V ac at 500 Hz from the AC Calibrator system.
19. Adjust R18 for a reading between 159.985 and 160.015 .
20. Increase the input frequency to 50 kHz .
21. Adjust C14 for a reading between 159.985 and 160.015 .
22. Select the 1000V range.
23. Apply an input of 1000V ac at 10 kHz from the AC Calibrator system.
24. Monitor the reading for 30 seconds. At the end of that time the reading should be between 999.20 and 1000.80 .

25. Verify that the values given in steps 9 through 12 of Table 609-3 are within the stated tolerances for the voltage and frequency listed.

Table 609-3. RMS AC Tests

INPUT				READING		
Step	Range	Voltage	Frequency	Minimum	Nominal	Maximum
1	1V	2.5V	300k	2.49000	2.50000	2.51000
2	1V	2.5V	20k	2.49925	2.50000	2.50075
3	1V	2.5V	50	2.49900	2.50000	2.50100
4	1V	2.5V	100k	2.48750	2.50000	2.51250
5	1V	0.25V	100k	0.24125	0.25000	0.25875
6	1V	2.5 mV	50k	0.00175	0.00250	0.00325
7	1V	2.5 mV	500	0.00225	0.00250	0.00275
8	1V	0.8V	500	0.79960	0.80000	0.80040
9	100V	160V	300k	157.000	160.000	163.000
10	10V	20V	300k	19.6000	20.0000	20.4000
11	1V	0.8V	300k	0.77500	0.80000	0.82500
12	1V	0.2V	300k	0.18800	0.20000	0.21200

609-31. Troubleshooting

609-32. Troubleshooting procedures for the RMS Converter follow the format used in Section 4. Table 609-4 assures that the problem actually is in the RMS Converter. Figure 609-2 gives a symptom analysis approach to troubleshooting, with possible failures listed in order of probability, and gives the address and data field used to set up the module. DO NOT remove modules with the power on.

609-33. PARTS LIST

609-34. Table 609-5 gives a parts breakdown for the AC/DC Converter (RMS). Refer to Section 5 for ordering information.



CAUTION

Indicated devices are subject to damage by static discharge.

Table 609-4. AC Converter Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Do the DC Performance Test (Section 4).		Section
2	Is DC Volts within tolerance?	3	4
3	Is the Calibration Memory module installed?	4	6
4	Remove the Calibration Memory module. Is AC OK?	5	6
5	Bad Calibration Memory. Go to Section 604.		
6	Is Isolator installed?	7	10
7	Replace Isolator with Bus Interconnect/Monitor pcb.		
8	Is AC OK?	9	10
9	Bad Isolator. Go to Section 608.		
10	Remove DC Signal Conditioner. Is AC OK?	11	12
11	DC Signal Conditioner interfering with AC. The problem in the DC Signal Conditioner is one of the following: 1. Digital Logic Bad, 2. K1 or K2 shorted, 3. Q6, Q7, Q8 Bad.		
12	Install Bus Interconnect/Monitor if not already installed.		
13	Check power supply voltages as follows: VA1 = +14.25 to 15.75V VA4 = -29 to -32V VA2 = -14.25 to -15.75V Vcc = -15V Difference = 4.9 VA3 = +29 to 32V Vss = -20V to 5.2		
14	Are the supply voltages OK?	15	Section 4
15	Go to Figure 609-2.		

Figure 609-2. Symptom Analysis

SYMPTOM	POSSIBLE FAILURE
High reading on display with open inputs, 1000V range	C24 misadjusted, Q9, Q10, U4
High frequency (300 kHz) bad	C24 misadjusted or bad, U3
Reading not stable	U3, U4
Crest factor bad	Q8, Q12
AC breaks down (overload source above 500V)	K7
AC out of tolerance in slow filter mode	Q13 and Q14, Q16 and Q17
One range bad	Digital Logic, Range Relays, CR14, CR16
All ranges bad	U3, Q1, U5, Q7, U7, U8, K8, K1
Excessive noise	U3, Q2
Display blanks	U1, U10

The largest single failure items tend to be relays and electrolytic capacitors

Note: If Q8 or Q12 is replaced, the module should be returned to the factory (Attn. Parts) for temperature compensation and adjustment of R38.

Address IC 0, 2, 4 high

ID0 = 0, ID1 = 0	— DC Coupled AC
ID0 = 1, ID1 = 0	— AC Volts
ID0 = 0, ID1 = 1	— RT1 input for AC Current
ID2 = 0	— Filter On
ID3 = 0	— 10V range
ID4 = 0	— 100V range
ID5 = 0	— 1000V range
ID3 through ID5 = 1	— 1V range

Table 609-5. AC/DC Converter (RMS)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
⊗	AC/DC CONVERTER (RMS) ASSEMBLY TESTED Figure: 609-3						
C1	Cap, film, 0.22 uF $\pm 20\%$, 1200V	268904	84411	JF-65	1		
C2	Cap, porc, 2.2 pF $\pm 0.25\%$, 1700V ac	340273	95275	VY10CA2R2CA	1		
C3	Cap, mica, 220 pF $\pm 5\%$, 500V	170423	72136	DM15F221J	1		
C4, C9	Cap, var, 0.25 –1.5 pF, 2000V	218206	74970	273-0001-001	2	1	
C7, C34, C39	Cap, film, 0.10 uF $\pm 10\%$, 100V	393439	89536	393439	3		
C8	Cap, porc, 5.1 pF ± 0.25 pF, 1000V	347948	95275	VY13C5R1C	1		
C10	Cap, mica, 43 pF $\pm 1\%$, 500V	277202	72136	DM15E430F	1		
C11	Cap, var, 0.8 –10 pF, 200V	229930	91293	JMC5201	1	1	
C12	Cap, film, 0.047 uF $\pm 10\%$, 250V	162008	89536	162008	1		
C13	Cap, mica, 390 pF $\pm 1\%$, 500V	355339	72136	DM15F391F	1		
C14	Cap, var, cer, 9–35 pF, 350V	289637	72982	538-006D-9-35	1	1	
C15	Cap, mica, 3600 pF, $\pm 2\%$, 500V	176644	72136	DM19F362G	1		
C16, C18, C20, C26, C31, C45	Cap, mica, 27 pF $\pm 5\%$, 500V	177998	72136	DM15E270J	6		
C17	Cap, mica, 8 pF $\pm 10\%$, 500V	216986	72136	DM15C080K	1		
C19, C22	Cap, mica, 1000 pF $\pm 5\%$, 500V	148387	72136	DM19F102J	2		
C21	Cap, mica, 2 pF ± 0.5 pF, 500V	175208	72136	DM15C020D	1		
C23, C36, C37	Cap, Ta, 15 uF $\pm 10\%$, 20V	153056	56289	150D156X 9020B	3		
C24	Cap, var, cer 1.7 –10 pF, 250V	321109	91293	9301	1	1	
C25	Cap, mica, 390 pF $\pm 5\%$, 500V	148437	72136	DM15F391J	1		
C27, C42	Cap, film, 0.0033 uF $\pm 10\%$, 50V	402867	06001	75F1R5A333	2		
C28	Cap, polyester, 0.01 uF $\pm 10\%$, 400V	402818	89536	402818	1		
C29, C41	Cap, film, 0.022 uF $\pm 10\%$, 250V	234484	89536	234484	2		
C30	Cap, film, 0.0068 uF $\pm 10\%$, 200V	106070	56289	192P68202	1		

Table 609-5. AC/DC Converter (RMS) (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C32, C35	Cap, film, 0.033 uF $\pm 10\%$, 250V	234492	89536	234492	2		
C33	Cap, film, 0.0047 uF $\pm 10\%$, 50V	260844	06001	75F1R5A347	1		
C40	Cap, mica, 15 pF $\pm 5\%$, 500V	148569	72136	DM15C150J	1		
C43	Cap, Ta, 6.8 uF $\pm 20\%$, 35V	363713	56289	196D85X0035 KA1	1		
CL1	Diode, FET, CUR REG	285106	07910	TCR5309	1	1	
CR2 thru CR5, CR8, CR9, CR10, CR17	Diode, Hi-speed Switching	203323	07910	1N4448	8	2	
CR6, CR7, CR14, CR16, CR20, CR25	Diode, lo-cap-lo-leak	375907	07263	FD7222	6	2	
CR11, CR15, CR18, CR24	Diode, zen, uncompn	246611	07910	1N961A	4	1	
CR19	Diode, rectifier, Si	180554	07910	CD12599	1	1	
CR21, CR22	Diode, zen, uncompn	260695	07910	1N754A	2	1	
K1, K7	Relay, coil	272070	71707	UD-L-P	2		
K1, K7	Switch, dry reed	219097	95348	MR5972	2		
K2	Coil, reed relay	269019	71707	U-6-P	1		
	Switch, dry reed (use with K1, K2, K7)	284091	95348	MR138MOD	3		
	Foil (use with K1, K2, K7)	313833	89536	313833	5		
K4, K5, K6, K8	Relay dry reed	357566	71707	UF40069	4		
Q1	Xstr, Dual, FET, N-channel (selected)	267963	89536	267963	1	1	
Q2, Q6, Q7	Xstr, FET, N-channel	343103	89536	343103	3	1	

Table 609-5. AC/DC Converter (RMS) (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q4, Q10, Q18, Q19	Xstr, NPN, Si	218396	04713	2N3904	4	1	
Q8, Q12	Xstr, Matched Set	341057	89536	341057	2	1	
Q9	Xstr, NPN, Si	218081	89536	218081	1	1	
Q11	Xstr, PNP, Si	195974	04713	2N3906	1	1	
Q13, Q16, Q17	Xstr, FET, N-channel	288324	89536	288324	3	1	
Q14	Xstr, FET, N-channel	393314	89536	393314	1	1	
Q15	Xstr, PNP, Si	218388	07263	2N3645	1	1	
Q20	Xstr, PNP, Si	226290	04713	MPS3640	1	1	
R1	Res, mf, 1M $\pm 0.1\%$, 1W	340265	03888	PME75	1		
R2	Res, comp, 22k $\pm 5\%$, 1/4W	148130	01121	CB2235	1		
R3	Res, mf, 2.0k $\pm 1\%$, 1/8W	235226	91637	MFF1-82001F	1		
R6, R7, R31	Res, mf, 50k $\pm 0.1\%$, 1/8W	340257	91637	MFF1-85002B	3		
R8	Res, mf, 48.7k $\pm 1\%$, 1/8W	267385	91637	MFF1-84872F	1		
R9, R35, R53, R59, R67, R70	Res, comp, 1M $\pm 5\%$, 1/4W	182204	01121	CB1055	6		
R10	Res, comp, 470 $\pm 5\%$, 1/4W	147983	01121	CB4715	1		
R11	Res, comp, 12k $\pm 5\%$, 1/4W	159731	01121	CB1235	1		
R12, R42, R45	Res, var, cermet, 1M $\pm 10\%$, 1/2W	334722	89536	334722	3	1	
R13	Res, mf, 399k $\pm 0.1\%$, 1/8W	417212	91637	MFF1-83993B	1		
R14	Res, var, cermet, 2k $\pm 10\%$, 1/2W	285163	89536	285163	1	1	
R15	Res, mf, 56.89k $\pm 0.1\%$, 1/8W	417220	91637	MFF1-856891B	1		
R16	Res, var, cermet, 500 $\pm 10\%$, 1/2W	291120	89536	291120	1	1	
R17	Res, mf, 6324 $\pm 0.1\%$, 1/8W	417238	91637	MFF1-86324B	1		
R18, R32	Res, var, cermet, 50 $\pm 10\%$, 1/2W	285122	89536	285122	2	1	
R19	Res, mf, 782.8 $\pm 0.1\%$, 1/8W	417246	91637	MFF1-8782R8B	1		

Table 609-5. AC/DC Converter (RMS) (Continued)

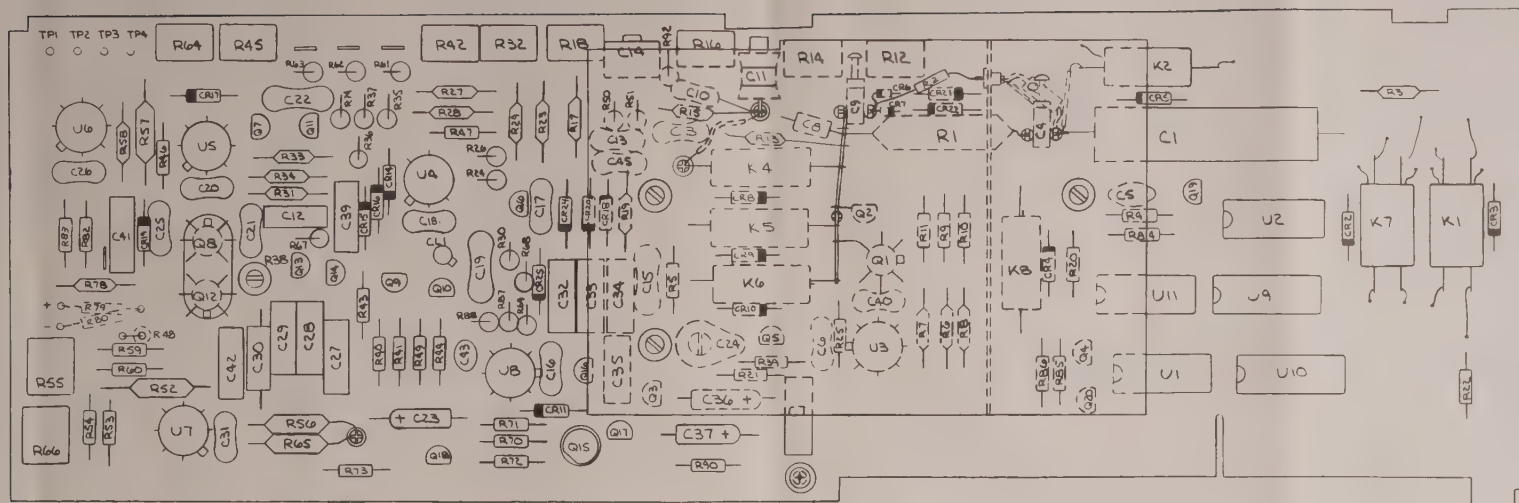
REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R20, R84	Res, comp, 4.7k $\pm 5\%$, 1/4W	148072	01121	CB4725	2		
R21	Res, comp, 100 $\pm 5\%$, 1/4W	147926	01121	CB1015	1		
R22	Res, comp, 330 $\pm 5\%$, 1/4W	147967	01121	CB3315	1		
R23	Res, mf, 4.975k $\pm 0.1\%$, 1/8W	340232	91637	MFF1-84975B	1		
R24	Res, comp, 5.1k $\pm 5\%$, 1/4W	193342	01121	CB5125	1		
R25	Res, comp, 3k $\pm 5\%$, 1/4W	193508	01121	CB3025	1		
R26	Res, comp, 3.9k $\pm 5\%$, 1/4W	148064	01121	CB3925	1		
R27, R58	Res, mf, 1M $\pm 1\%$, 1/8W	268797	91637	MFF1-81004F	2		
R28	Res, mf, 121 $\pm 1\%$, 1/8W	343160	91637	MFF1-81210F	1		
R29	Res, mf, 5k $\pm 0.1\%$, 1/8W	340240	91637	MFF1-85001B	1		
R30, R37, R40	Res, comp, 5.6k $\pm 5\%$, 1/4W	148080	01121	CB5625	3		
R33	Res, mf, 100k $\pm 0.1\%$, 1/8W	340166	91637	MFF1-81003B	1		
R34	Res, mf, 35.7k $\pm 1\%$, 1/8W	288480	91637	MFF1-83572F	1		
R36	Res, comp, 82 $\pm 5\%$, 1/4W	149484	01121	CB8205	1		
R38	Res, var, cermet, 3 $\pm 25\%$, 1/2W	347963	32997	3329H-J81-3R0	1	1	
R41	Res, comp, 56k $\pm 5\%$, 1/4W	170738	01121	CB5635	1		
R43, R82	Res, comp, 1k $\pm 5\%$, 1/4W	148023	01121	CB1025	2		
R44	Res, comp, 9.1k $\pm 5\%$, 1/4W	193318	01121	CB9125	1		
R46, R54, R60	Res, comp, 560 $\pm 5\%$, 1/4W	147991	01121	CB5615	3		
R47	Res, comp, 51k $\pm 5\%$, 1/4W	193334	01121	CB5135	1		
R49, R83	Res, comp, 330 $\pm 5\%$, 1/4W	147967	01121	CB3315	2		
R50	Res, comp, 22k $\pm 5\%$, 1/4W	147884	01121	CB2235	1		
R51	Res, comp, 47k $\pm 5\%$, 1/4W	148163	01121	CB4735	1		
R52	Res, mf, 4.02M $\pm 1\%$, 1/4W	417253	91637	MFF1-440203F	1		
R55, R66	Res, var, cermet, 1M $\pm 10\%$, 1/2W	276691	89536	276691	2	1	
R56, R65	Res, mf, 2M $\pm 0.25\%$, 1/2W	327502	91637	MFF1-22004C	2		
R57	Res, mf, 930k $\pm 0.25\%$, 1/4W	417345	91637	MFF1-49303C	1		

Table 609-5. AC/DC Converter (RMS) (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R61	Res, mf, 17.4k $\pm 1\%$, 1/8W	236802	91637	MFF1-81742F	1		
R62	Res, mf, 34k $\pm 1\%$, 1/8W	261602	91637	MFF1-83402F	1		
R63	Res, mf, 68.1k $\pm 1\%$, 1/8W	236828	91637	MFF1-86812F	1		
R64	Res, var, cermet, 20k $\pm 10\%$, 1/2W	291609	89536	291609	1	1	
R68	Res, comp, 200k $\pm 5\%$, 1/4W	248781	01121	CB2045	1		
R69	Res, comp, 750k $\pm 5\%$, 1/4W	221937	01121	CB7545	1		
R71	Res, comp, 470k $\pm 5\%$, 1/4W	188441	01121	CB4745	1		
R72	Res, comp, 22k $\pm 5\%$, 1/4W	148130	01121	CB2235	1		
R73	Res, comp, 100k $\pm 5\%$, 1/4W	148189	01121	CB1045	1		
R74, R85	Res, comp, 20k $\pm 5\%$, 1/4W	221614	01121	CB2035	2		
R78	Res, mf, 10 $\pm 1\%$, 1/8W	268789	91637	MFF1-8A100F	1		
R86, R90	Res, comp, 150 $\pm 5\%$, 1/4W	147934	01121	CB1515	2		
R87, R88, R92	Res, comp, 10k $\pm 5\%$, 1/4W	148106	01121	CB1035	3		
U1	⊗ IC, Dgtl, C-MOS, quad, 2-input, NAND gates	375147	02735	CD4023AE	1	1	
U2	IC, TTL, hex inverter, buffer/driver	288605	01295	SN7416N	1	1	
U3	IC, Lin, Op-Amp	329912	12040	LM318H	1	1	
U4	IC, Op-Amp	225961	24355	AD3092	1	1	
U5	IC, Lin, Op-Amp	288928	12040	LM308AH	1	1	
U6, U7	IC, Lin, Op-Amp	284760	12040	LM308H	2	1	
U8	IC, Op-Amp	381889	12040	LM201A	1	1	
U9	⊗ IC, Dgtl, C-MOS, hex, inverter/buffer	381848	02735	CD4049AE	1	1	
U10	⊗ IC, Dgtl, C-MOS, hex "D" flip-flop	404509	12040	MM74C174N	1	1	
U11	⊗ IC, Dgtl, C-MOS, quad 2-input, NAND gates	355198	02735	CD4011AE	1	1	
	Casehalf, Module	402990	89536	402990	2		
	Cover, module case	402974	89536	402974	1		
	Decal	413393	89536	413393	1		
	Guard, front	383356	89536	383356	1		

Table 609-5. AC/DC Converter (RMS) (Concluded)

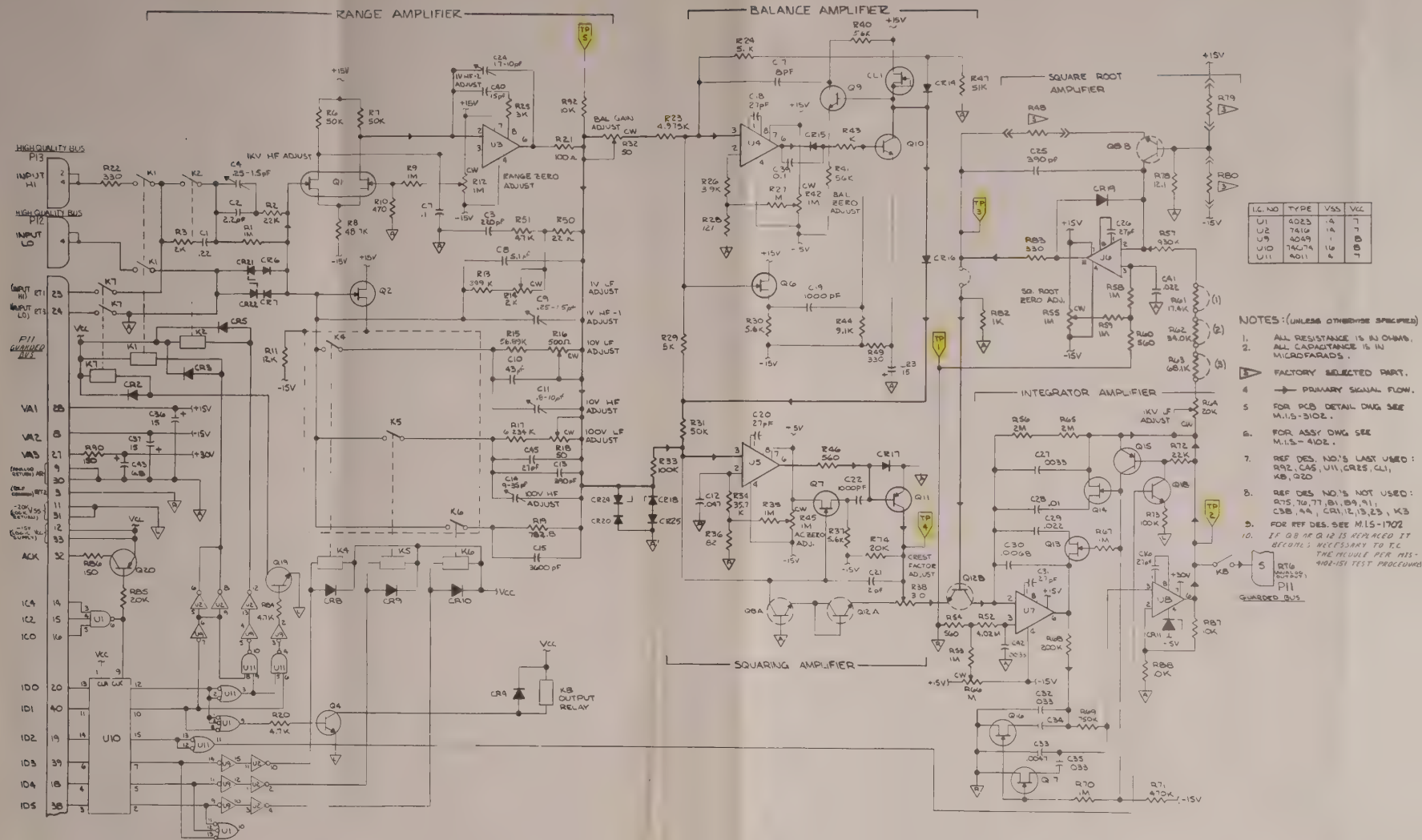
REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Guard, rear	383364	89536	383364	1		
	Heatsink	347740	89536	347740	1		
	Insulator, RMS Shield	426932	89536	426932	1		
	Shield, cover	411934	89536	411934	1		
	Shield, input, RMS conv	390484	89536	390484	1		
	Shield, RMS conv	416214	89536	416214	1		
	Socket, comp, lead	343285	00779	2-331272-6	5		
	Spacer, Xstr, Mtg (use with CL1)	175125	07047	10172-DAP	1		
	Spacer, Xstr, Mtg (use with Q15)	152207	07047	10123DAP	1		



NOTES:

1. FOR SCHEMATIC DIAGRAM SEE M.I.S.-1102.
2. FOR P.C.B. SEE M.I.S.-3102.
3. FOR ASSEMBLY DES. SEE M.I.S.-4101.

Figure 609-3. AC/DC Converter (RMS) Assembly
(M.I.S.-1702)



Option —09A AC/DC Converter (RMS)

609A-1. INTRODUCTION

609A-2. The AC/DC Converter (RMS) is used to provide accurate ac or ac + dc measurements without error due to waveform distortion. Measurements up to 1000 Vac in four ranges with a bandwidth of 10 Hz to 300 kHz may be made (input volt-hertz product not to exceed 2×10^7). Input impedance is $1 \text{ M}\Omega$ shunted by less than 100 pf.

609A-3. SPECIFICATIONS

609A-4. Table 609-1 lists the specifications for the true RMS Converter.

609A-5. INSTALLATION

609A-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing the AC/DC Converter (RMS) module. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

609A-7. OPERATING NOTES

609A-8. Operation of the front panel controls is the same as described in Section 2. An ac voltage on a dc level may be measured by depressing both the Vdc and the Vac function switches at the same time. The reading displayed will be the rms value of the two voltages combined. External reference inputs at the rear panel must be dc voltages only. The slow filter (FILTER LED illuminated) must be selected for full accuracy below 400 Hz.

609A-9. THEORY OF OPERATION

609A-10. The function of the RMS Converter is to accept signals from either the input terminals or the optional

Current Shunts module and to convert the input signal to a dc level proportional to the rms value of the input. The dc output from the RMS Converter is routed on the Guarded Bus to the Active Filter module and then to the A/D Converter. True rms conversion is mathematically obtained by averaging the squared value of the input, then taking the square root ($V_{\text{rms}} = \sqrt{V_{\text{in}}^2}$). Limitations to the realization of this mathematical formula using operational techniques are crest factor (ratio of peak value to rms value, limited by the dynamic range of the amplifiers), frequency response, and accuracy.

609A-11. Input signals are applied to the Range Amplifier (Q1, U3) to be brought within the 1V rms range. Refer to Figure 609A-1. Before a signal can be operationally squared, it must be converted to an absolute value. Balance Amplifier (U4, Q10) performs this function by inverting and rectifying the signal from U3. Outputs from the Range Amplifier and the Balance Amplifier are applied through R33 and R31 to the summing node of the Squaring Amplifier (U5, Q11). Due to the ratio of R33 to R31, the inverted negative half-cycles from the Balance Amplifier are twice the amplitude of the negative half-cycles from the Range Amplifier. When summed, the waveform is the absolute value of the output from the Range Amplifier. The conversion to rms is performed by the Squaring Amplifier, Integrator, and Square Root Amplifier. Implementation of these functions depends on the logarithmic response of PN junctions. Since two PN junctions are used in each of two parts of a feedback loop, a double logarithmic response is generated ($2 \log X = \log X^2$). The Squaring Amplifier converts the signal to a current flowing through the emitters of two transistors, Q8A and Q12A. These two transistors are configured with two additional transistors, Q12B and Q8B, in a feedback loop which constrains the output voltage to be the square root of the integral of the square of the current flowing in Q8A and Q12A.

Table 609A-1. AC/DC Converter (RMS) Specifications

Input Characteristics

RANGE	FULL SCALE 5½ DIGITS	RESOLUTION		INPUT IMPEDANCE
		6½ DIGITS*	5½ DIGITS	
1V	2.50000V	1 μ V	10 μ V	1 M Ω shunted by <100 pf
10V	20.0000V	10 μ V	100 μ V	
100V	160.000V	100 μ V	1 mV	
1000V	1000.00V	1 mV	10 mV	

*In AVG operating mode (8505A/8506A).

Accuracy $\pm$ (% OF READING + % OF FULL SCALE)¹

24 HOUR 23°C $\pm$ 1°C				90 DAY 23°C $\pm$ 5°C			
FREQUENCY*	% OF READING	% FS		FREQUENCY*	% OF READING	% FS	
		AC	AC + DC			AC	AC + DC
DC	0.075	—	0.03	DC	0.1	—	0.03
10 Hz - 20 Hz	0.75	0.04	0.06	10 Hz - 20 Hz	1.0	0.04	0.06
20 Hz - 50 Hz	0.35	0.012	0.03	20 Hz - 50 Hz	0.5	0.012	0.03
50 Hz - 10 kHz	0.075	0.012	0.03	50 Hz - 10 kHz	0.1	0.012	0.03
10 kHz - 30 kHz	0.15	0.04	0.06	10 kHz - 30 kHz	0.2	0.04	0.06
30 kHz - 50 kHz	0.2	0.1	0.12	30 kHz - 50 kHz	0.3	0.1	0.12
50 kHz - 100 kHz	0.75	0.3	0.3	50 kHz - 100 kHz	1.0	0.3	0.3
100 kHz - 300 kHz	1.5	0.5	0.5	100 kHz - 300 kHz	2.0	0.5	0.5
300 kHz - 1 MHz	2.9	1.3	1.3	300 kHz - 1 MHz	3.3	1.8	1.8

*Slow filter must be used for full accuracy below 400 Hz.

>90 DAY 23°C $\pm$ 5°C

ADD TO THE 90 DAY SPECIFICATIONS PER MONTH THE FOLLOWING %:

FREQUENCY*	% OF READING	% FS	
		AC	AC + DC
DC	0.011	—	0.0033
10 Hz - 20 Hz	0.11	0.0044	0.0067
20 Hz - 50 Hz	0.056	0.0031	0.0033
50 Hz - 10 kHz	0.011	0.0031	0.0033
10 kHz - 30 kHz	0.022	0.0044	0.0067
30 kHz - 50 kHz	0.033	0.056	0.014
50 kHz - 100 kHz	0.11	0.033	0.033
100 kHz - 300 kHz	0.089	0.056	0.056
300 kHz - 1 MHz	0.044	0.033	0.033

Operating Characteristics

CREST FACTOR >7 at Full Scale, increasing down range by:
 $7 \times \sqrt{V \text{ Range} / V \text{ Reading}}$

TEMPERATURE COEFFICIENT $\pm$ (% OF READING + % OF FULL SCALE) / °C*

MODE	0°C TO 18°C AND 28°C TO 50°C
AC	0.004 + 0.002
AC + DC	0.004 + 0.004

*For frequencies <10 kHz.

Table 609A-1. AC/DC Converter (RMS) Specifications (cont)

COMMON MODE REJECTION >120 dB, dc to 60 Hz, with 100Ω in series with either lead.

RESPONSE TIME

Analog Settling Time 100 ms with Fast Filter and 500 ms with Slow Filter to within 0.1% of in-range step change.

Digitizing Time Same as dc volts (see Section 1).

MAXIMUM INPUT VOLTAGE 1000V rms, 1400V peak, or volts-hertz limit, whichever is less.

VOLTS-HERTZ LIMIT 1×10^7 for 1V and 10V ranges

2×10^7 for 100V and 1000V ranges

NOTES:

¹For inputs >0.1% of range to full scale.

For inputs >500V, multiply accuracy specification by (Input voltage + 2000V) / 2000V.

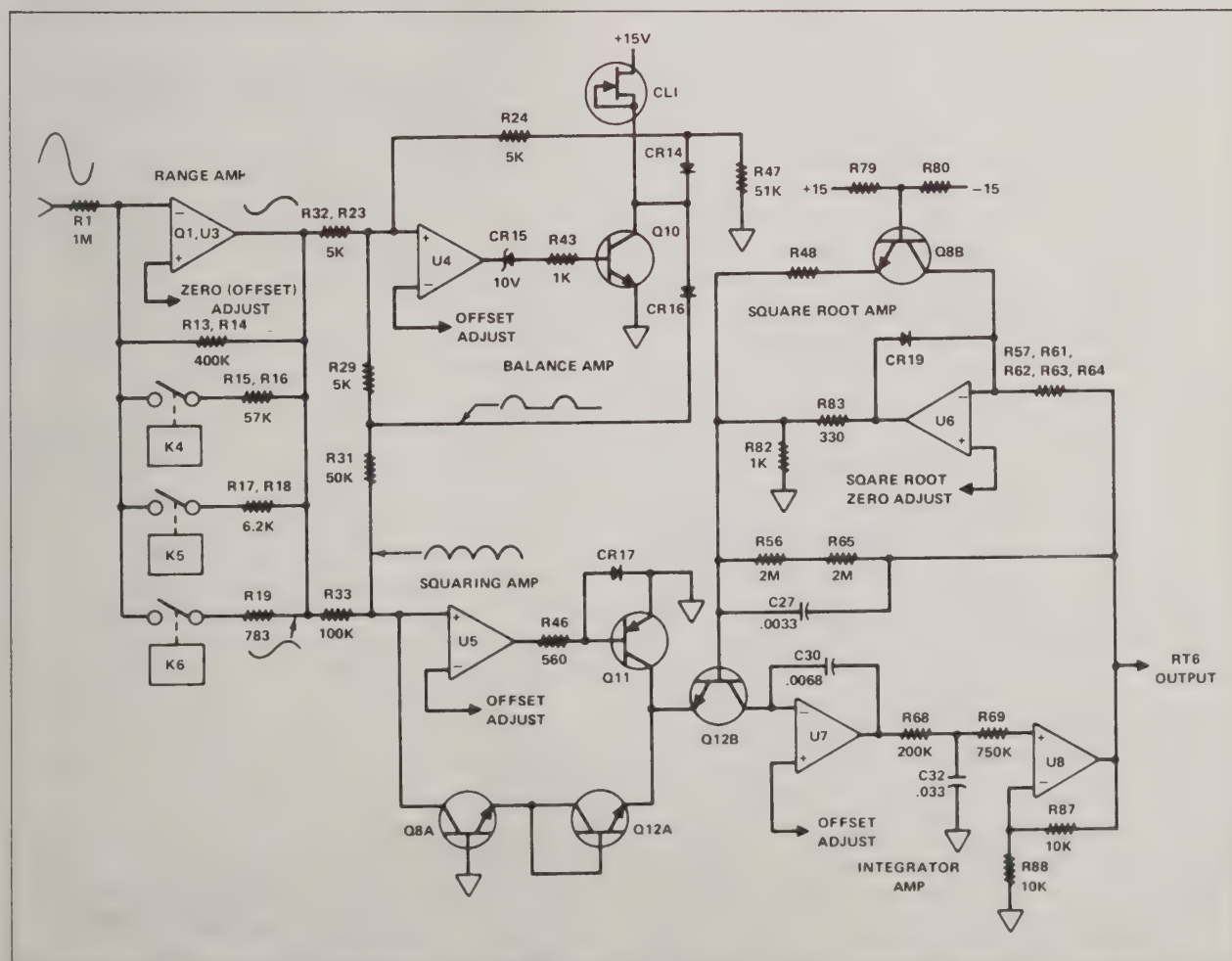


Figure 609A-1. AC/DC Converter (RMS)

609A-12. Circuit Description

609A-13. Refer to the schematic for the following discussion.

609A-14. RANGE AMPLIFIER

609A-15. The Range Amplifier is an inverting amplifier with gain control provided by switching feedback impedances. Feedback impedances are controlled by relays K4, K5, or K6, and consist of parallel resistors and capacitors adjusted for proper gain and frequency response. Relays K1, K2, and K7 control the input to the amplifier. K1 is energized for inputs from the input terminals. K7 is energized for inputs from the Current Shunts module. K2 is energized when selecting ac + dc measurements. Gain of the amplifier is set for a 1V rms output with a full-scale sine wave input with the exception of the 1000V range in which the full-scale output is .8V rms. Q1 and U3 provide the forward gain of the amplifier. CR6, CR7, CR21, and CR22 provide input protection. Q2 drives the guard for the summing node of the operational amplifier.

609A-16. BALANCE AMPLIFIER

609A-17. The Balance Amplifier is an inverting, unity-gain amplifier with diodes in the feedback paths to provide rectification. CL1 and Q10 are configured as a current source driven by U4. A high impedance current source is used to minimize the effects of the diodes on the gain of the amplifier. Due to the unity gain of the inverting amplifier and the ratio of R33 to R31, the negative half-cycles from the Range Amplifier are summed with positive half-cycles having twice the amplitude from the Balance Amplifier. The result is the absolute value of the output from the Range Amplifier. Q6 is used to extend the frequency response of the amplifier.

609A-18. COMPUTATION

609A-19. The Squaring Amplifier, Square Root Amplifier, and Integrator Amplifier work together to perform the rms conversion. This is accomplished by regulating the current in four transistors, Q8A, Q12A, Q8B, and Q12B, matched for temperature coefficient and response characteristics. The Squaring Amplifier sums the outputs from the Range Amplifier and the Balance Amplifier such that the current flowing through its feedback path (Q8A, Q12A) is proportional to the absolute value of the input signal. Forward gain of the amplifier is provided by U5 and Q11 with Q7 extending the frequency response.

609A-20. Q12B is configured such that the integral of its collector current is the output voltage. U7 and U8 integrate the collector current of Q12B. Q8B is configured such that its collector current is proportional to the output voltage. The current through Q8B controls the gain of U6, the Square Root Amplifier, which in turn partially controls the current flowing in Q12B. The integrating time constant

of U7 and U8 is determined by R56 and R65 in parallel with C27 or C27 plus C28, depending on which filter is selected from the front panel. The proportionality constant of the converter is such that a full-scale input produces a 20V output on RT6.

609A-21. MAINTENANCE

609A-22. Performance Test

609A-23. Use the following procedure as a performance determination for the AC/DC Converter (RMS). The DC Volts Performance Test given in Section 4 should be done first to ensure proper DC accuracy.

1. Select AC Volts and Autoranging.
2. Connect the AC Calibrator output to the instrument input terminals.
3. Sequentially apply the input voltages and frequencies listed in Table 609A-2, verifying that the instrument reading is within the listed tolerance.
4. Disconnect the AC Calibrator and connect the DC Calibrator.
5. Simultaneously select DC Volts and AC Volts (both indicators illuminated).
6. Select an output from the DC Calibrator of +10.0000 Vdc.
7. The instrument display should be within 9.9840 and 10.0160.
8. Reverse the leads at the output of the DC Calibrator. The display should still read within the limits of Step 8.

Table 609A-2. Performance Test

INPUT		8500A READING	
FREQ	VOLTAGE	LOW	HIGH
10 kHz	1 V	0.99870	1.00130
50 kHz	1 V	0.99450	1.00550
10 kHz	10 V	9.9876	10.0124
50 kHz	10 V	9.9500	10.0500
10 kHz	100 V	99.881	100.119
50 kHz	100 V	99.540	100.460
10 kHz	1000 V	998.48	1001.52

609A-24. Calibration

609A-25. Before calibrating the RMS Converter, perform the DC Calibration procedure in Section 4. Remove the Calibration Memory if installed and allow a two hour warm-up. Allow adequate warm-up time for the Calibrator used, as specified in the Calibrator manual. After calibration is complete, reinstall the Calibration Memory and enter new values at the cardinal points of each range (zero may be entered).

609A-26. Use the following procedure to calibrate the AC/DC Converter (RMS). All adjustments given are on the RMS Converter and are accessible at the top of the module. R66, R55, C24 and R38 are adjustments not accessible from the top of the module which should not require adjustment unless parts have been replaced. Adjustment procedures for these adjustments are given in Troubleshooting in this section of the manual.

609A-27. Range Zero Adjustment is accomplished using the following steps:

1. Select the 10V range.
2. Simultaneously select DC Volts and AC Volts (both indicators illuminated).
3. Connect the test DVM HI to TP5, LO to TP1.
4. Short the input terminals.
5. Adjust R12, RANGE ZERO, for a reading on the test DVM of $0 \pm 30 \mu\text{V}$.
6. Remove the input short and the test DVM.

609A-28. Balance Zero Adjustment is accomplished using the following steps:

1. Apply -0.2000000 to the input terminals from the DC Calibrator. Record the reading.
2. Reverse the polarity of the input.
3. Adjust R42, BALANCE ZERO, twice as far as required to reach the reading noted.
4. Reverse polarity again. Readjust R42 until the readings are within $10 \mu\text{V}$ for either polarity without further adjustment.

609A-29. Balance Gain Adjustment is accomplished using the following steps:

1. Select the Cal mode (CAL switch down, CAL indicator illuminated). Ignore the cal digit for the remainder of this procedure.

NOTE

Entering the cal mode allows over-range inputs without the over-range indication flashing.

2. Apply -20.00000 Vdc to the input from the DC Calibrator. Note the reading.
3. Reverse the polarity.
4. Adjust R32, BALANCE GAIN, to the reading noted.
5. Reverse the polarity again. Readjust R32 until the readings with both polarities are within 10 digits without further adjustment.

609A-30. AC Zero Adjustment is accomplished using the following steps:

1. Select AC Volts, 1V range.
2. Connect the AC Calibrator to the input terminal.
3. Apply 2.5 mV AC, 500 Hz to the input.
4. Adjust R45, AC ZERO, for a reading between 0.00245 and 0.00255.

609A-31. Calibration Adjustments

609A-32. Sequentially apply the input voltages and frequencies listed in Table 609A-3, performing the adjustments as necessary to bring the reading within the stated tolerance. Select AC Volts and manual ranging for these adjustments. If in the first step R64 does not have the required range, perform the coarse calibration in the troubleshooting section. Steps 9 and 24 require a 50Ω termination at the instrument input terminals and the use of four-wire sensing with the AC Calibrator. Two test cables, each with twisted wires, may be used.

609A-33. Troubleshooting

609A-34. Troubleshooting procedures for the AC/DC Converter (RMS) follow the format used in Section 4. Table 609A-4 assures that the problem actually is in the RMS Converter. Figure 609A-2 gives a symptom analysis approach to troubleshooting, with possible failures listed in order of probability, and gives the address and data field used to set up the module. DO NOT remove or install modules with the power on.

609A-35. If Q8 or Q12 are replaced, the module must be returned to the factory (attn: PARTS) for temperature compensation. This is also the only time R38, CREST FACTOR ADJUST, should require readjustment. Do not attempt to adjust R38 as no crest factor generators are commercially available.

Table 609A-3. Calibration Adjustment

STEP	RANGE	INPUT		ADJUST/ CHECK	TOLERANCE	
		VOLTAGE	FREQUENCY		LOW	HIGH
1	1000V	500V ¹	500 Hz	R64	499.90	500.10
2	1000V	500V ¹	50 kHz	C4	499.80	500.20
3	1000V	1000V ¹	10 kHz	Wait 30 sec. Check	999.20	1000.80
4	1V	2.5V	500 Hz	R14	2.49975	2.50025
5	1V	2.5V	50 kHz	C9	2.49900	2.50100
6	10V	20V	500 Hz	R16	19.9980	20.0020
7	10V	20V	50 kHz	C11	19.9900	20.0100
8	10V	10V	1 MHz	Check (R75) ²	9.8000	10.2000
9	1V	1V	1 MHz ³	Check (R75) ²	0.9800	1.02000
10	1V	2.5V	300 kHz	Check	2.48000	2.52000
11	1V	2.5V	20 kHz	Check	2.49900	2.50100
12	1V	2.5V	50 Hz ⁴	Check	2.49900	2.50100
13	1V	2.5V	100 kHz	Check	2.49000	2.51000
14	1V	.25V	100 kHz	Check	0.24600	0.25400
15	1V	2.5 mV	50 kHz	Check	0.00150	0.00350
16	1V	2.5 mV	500 Hz	Check	0.00230	0.00270
17	1V	.8V	500 Hz	Check	0.79960	0.80040
18	100V	160V ¹	500 Hz	R18	159.960	160.020
19	100V	160V ¹	50 kHz	C14	159.960	160.040
20	100V	67V	300 kHz	Check	66.800	68.200
21	10V	20V	300 kHz	Check	19.7500	20.2500
22	1V	.8V	300 kHz	Check	0.78500	0.81500
23	1V	.2V	300 kHz	Check	0.18800	0.21200
24	1V	.1V	1 MHz ³	Check	0.07000	0.13000
1. Use CAUTION, Dangerous voltage. 2. If R75 is adjusted, repeat the previous steps. 3. Terminate cable in 50Ω; use four-wire sense on Calibrator as explained in the text. 4. FILTER must be ON.						

Table 609-4. AC Converter Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Do the DC Performance Test (Section 4).		Section
2	Is DC Volts within tolerance?	3	4
3	Is the Calibration Memory module installed?	4	6
4	Remove the Calibration Memory module. Is AC OK?	5	6
5	Bad Calibration Memory. Go to Section 604.		
6	Is Isolator installed?	7	10
7	Replace Isolator with Bus Interconnect/Monitor pcb.		
8	Is AC OK?	9	10
9	Bad Isolator. Go to Section 608.		
10	Remove DC Signal Conditioner. Is AC OK?	11	12
11	DC Signal Conditioner interfering with AC. The problem in the DC Signal Conditioner is one of the following: 1. Digital Logic Bad, 2. K1 or K2 shorted, 3. Q6, Q7, Q8 Bad.		
12	Install Bus Interconnect/Monitor if not already installed.		
13	Check power supply voltages as follows: VA1 = +14.24 to 15.75V VA2 = -14.25 to -15.75V VA3 = +29 to 32V VA4 = -29 to -32V Vcc = -15V Difference = 4.9 Vss = -20V to 5.2		
14	Are the supply voltages OK?	15	Section 4
15	Go to Figure 609-2.		

SYMPTOM	POSSIBLE FAILURE
High reading on display with open inputs, 1000V range	C24 misadjusted, Q9, Q10, U4
High frequency (300 kHz) bad	C24 misadjusted or bad, U3
Reading not stable	U3, U4
Crest factor bad	Q8, Q12
AC breaks down (overload source above 500V)	K7
AC out of tolerance in slow filter mode	Q13 and Q14, Q16 and Q17
One range bad	Digital Logic Range Relays, CR14, CR16
All ranges bad	U3, Q1, U5, Q7, U7, U8, K8, K1
Excessive noise	U3, Q2
Display blanks	U1, U10
The largest single failure items tend to be relays and electrolytic capacitors	
<i>Note: If Q8 or Q12 is replaced, the module should be returned to the factory (Attn. Parts) for temperature compensation and adjustment of R38.</i>	
Address IC 0, 2, 4 high	
ID0 = 0, ID1 = 0	-DC Coupled AC
ID0 = 1, ID1 = 0	-AC Volts
DIO = 0, ID1 = 1	-RT1 input for AC Current
ID2 = 0	-Filter On
ID3 = 0	-10V range
ID4 = 0	-100V range
ID5 = 0	-1000V range
ID3 through ID5 = 1	-1V range

Figure 609-2. Symptom Analysis

609A-36. Preliminary Calibration

609A-37. If other parts are replaced, it may be necessary to make the following adjustments before continuing with the calibration procedure. To assure proper functioning of the module the following procedure should be completed. Many of the adjustments must be performed again in the final calibration procedure. Always perform final calibration from the beginning of the procedure. Select the cal mode by placing the CAL switch in the down position. Ignore the cal digit for this procedure. Some of these adjustments are not accessible from the top of the module. Center all adjustments before beginning calibration except for R38, C24, and R64. R64 should be set fully counterclockwise. R38 should NOT be changed.

CAUTION

When high voltages are applied to the input terminals and the module is not enclosed in the case, hazardous voltages are present on the board. Use an insulated tool for making adjustments while keeping hands away from the PCB.

1. Select AC Volts and the 1V range (manually) and short the input terminals.
2. Short TP3 and TP4 to the metal divider on the board.
3. Connect the test DVM HI to TP2 and LO to TP1.
4. Adjust R66, INTEGRATOR ZERO, for 0V $\pm 100 \mu\text{V}$.
5. Remove the short from TP3.
6. Add a jumper from the ^{top, P1} ~~bottom~~ of R57 (junction with R61) to a jumper added across R48.
7. Connect the test DVM HI to TP3.
8. Adjust R55, SQUARE ROOT ZERO, for 0V $\pm 100 \mu\text{V}$.
9. Remove the short from TP4 and the jumper from R48.
10. Simultaneously select AC Volts and DC Volts; manually select the 10V range.
11. Connect the test DVM HI to TP5.
12. Adjust R12, RANGE ZERO, for 0V $\pm 30 \mu\text{V}$.
13. Disconnect the test DVM and remove the short from the input terminals.
14. Center R45, AC ZERO, and apply -0.2V from the DC Calibrator to the input terminals. Note the reading on the display.
15. Reverse the polarity of the input and adjust R42, BALANCE ZERO, twice as far as required to reach the reading noted.
16. Reverse the polarity again and readjust R42 until the readings obtained with both polarities are within 10 digits without further adjustment.
17. Apply -20V DC to the input and note the reading.
18. Reverse the input polarity and adjust R32, BALANCE GAIN, for the same reading as noted in the last step ± 5 digits.
19. Apply -0.02V DC and adjust R45, AC Zero, for a reading of 0.0200 ± 5 digits.
20. Disconnect the DC Calibrator and connect the AC Calibrator.
21. Select AC Volts and the 1000V range.
22. Set R64 fully counterclockwise.
23. Apply 500V @ 500 Hz to the input from the AC Calibrator.
24. Note the reading and clip links according to Table 609A-5. Link 1 is across R61, link 2 is across R62, and link 3 is across R63.
25. Adjust R64, 1000V LOW FREQ, ADJUST, for a reading of 500.000V ± 20 digits.
26. Change the frequency to 50 kHz and adjust C4, 1000V HIGH FREQ ADJUST, for 500.000V ± 20 digits.
27. Apply 2.5V @ 500 Hz to the input and manually select the 1V range.
28. Adjust R14, 1V LF, for 2.50000 ± 10 digits.
29. Change the input frequency to 500 kHz and adjust C9, 1V HF-1, for 2.50000 ± 100 digits.
30. Change the input frequency to 500 kHz and adjust C24, 1V HF-2, to bring the reading toward 2.5V. Adjusting C24 will require re-adjusting C9. Alternately adjust C9 as in step 29, then C24 @ 500 kHz until a reading of 2.50000V ± 3000 digits is obtained.

NOTE

C9 has approximately twice the effect at 500 kHz as at 50 kHz. If C24 hasn't enough range, adjust R75, 1 MHz. Turn it CW to raise the reading or CCW to lower the reading (½ turn is about 3000 digits).

31. Check the stability by selecting the 1000V range and applying 1000V @ 10 kHz. The reading should be 1000.00 $\pm$ 80 digits. Wait thirty seconds. If the reading is out of tolerance, with caution and an insulated tool, adjust C24 slightly beyond the point where a stable reading is displayed. Recheck steps 29 and 30.
32. Apply 20V @ 500 Hz and select the 10V range.
33. Adjust R16, 10V LF, for a reading of 20.0000 $\pm$ 20 digits.
34. Change the frequency to 50 kHz and adjust C11, 10V HF, for 20.0000 $\pm$ 100 digits.
35. Apply 10V @ 1 MHz using four-wire sensing (without the 50 Ω termination).
36. Adjust R75, 1 MHz, for a reading of 10.0000 $\pm$ 100 digits.
37. Apply 1V @ 1 MHz using four-wire sensing with the 50 Ω termination at the input terminals. Manually select the 1V range.
38. Initially note the reading without adjusting R75. If this reading is not 1.00000V $\pm$.036V, adjust C24 until the reading is within $\pm$.036V and note this reading. Adjust R75 until the reading is halfway between the noted reading and 1.00000V. This final reading, then, should be 1.00000V $\pm$.018V.
39. Apply 500V @ 50 kHz. The reading should be 500.00 $\pm$ 20 digits (adjust C4 if necessary).
40. Apply 2.5V @ 500 kHz and check reading for 2.50000 $\pm$.03V. Adjust C24 if necessary to bring the reading within the specification.
41. If C24 was adjusted in Step 40, check the stability by applying 1000V @ 10 kHz. The reading should be stable at 1000.00 $\pm$.8V. Re-adjust C24 and repeat Step 40 if the reading is unstable.
42. Apply 2.5V @ 50 kHz. Adjust C9 if necessary for a reading of 2.50000 $\pm$.001V.
43. Apply 20V @ 50 kHz and adjust C11 if necessary for a reading of 20.0000 $\pm$.01V.
44. Apply 10V @ 1 MHz using a four-wire cable. The reading should be 10.0000 $\pm$.02V.

45. Apply 1V @ 1 MHz using a four-wire cable with a 50 Ω termination. The reading should be 1.00000 $\pm$.02V.
46. If Steps 44 or 45 are out of tolerance repeat Steps 36 through 45.
47. Select the 100V range and apply 160V @ 500 Hz. Verify that R18, 100V LF, will adjust the reading to 160.000V $\pm$ 50 digits.
48. Check the output ripple by turning the filter off and applying 2.5V @ 200 Hz from a lab oscillator on the 1V range and adjust the oscillator output for a reading of 2.50000V $\pm$ 1000 digits. Connect the oscilloscope HI to TP2, LO to shield. The ripple should be less than 20 mV P-P.
49. Change the frequency to 20 Hz and turn the filter on. Readjust the voltage as in step 44. The ripple should be less than 80 mV P-P.
50. Perform the Calibration procedure (Paragraph 609A-24).

**Table 609A-5. High Voltage, Low Frequency
Coarse Adjust**

Reading	Links Previously Clipped	Clip Links	Replace Links
500 - 495.5 N/A (Pot R64 should adjust properly)		None	None
495.5 - 491.1	1	2	1
	2	1	None
	1 & 2	3	1 & 2
	3	1	None
	1 & 3	2	1
	2 & 3	1	None
500 - 504.5	1	None	1
	2	1	2
	1 & 2	None	1
	3	1 & 2	3
	1 & 3	None	1
	2 & 3	1	3
	1, 2, & 3	None	1

609A-38. PARTS LIST

609A-39. Table 609A-6 gives a parts breakdown for the AC/DC Converter (RMS). Refer to Section 5 for ordering information.

**CAUTION**

Indicated devices are subject to damage by static discharge.

Table 609A-6. RMS Converter PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-09A②	RMS CONVERTER PCB ASSEMBLY FIGURE 609A-3 (MIS-4103T)	ORDER	BY	OPTION -09A			
C1	CAP, MYLAR, 0.22 UF +/-20%, 1200V	268904	89536	268904	1		
C2	CAP, PORC, 1.5 PF +/-0.25 PF, 1.7V ACK	461004	95275	VY10CA1R5CA	1		
C3	CAP, MICA, 220 PF +/-5%, 500V	170423	72136	DM15F221J	1		
C4	CAP, VAR, 0.25-1.5 PF, 2000V	218206	72982	530-000	2		
C7	CAP, MYLAR, 0.1 UF +/-10%, 100V	393439	73445	C280MAH/A100K	2		
C8	CAP, PORC, 5.6 PF +/-0.25 PF, 100V	460568	95275	VY10CA5R6CA	1		
C9	CAP, VAR, 0.25-1.5 PF, 2000V	218206	72982	530-000	REF		
C10	CAP, MICA, 43 PF +/-1%, 500V	277202	72136	DM15E430F	1		
C11	CAP, VAR, 0.8-10. PF, 250V	229930	91293	JM2951	1		
C12	CAP, POLY FILM, 0.047 UF +/-10%, 250V	162008	73445	C280MAE/A47K	1		
C13	CAP, MICA, 390 PF +/-1%, 500V	355339	72136	DM15F391F	1		
C14	CAP, VAR, 9-35 PF, 350V	289637	72982	538-006D9-35	1		
C15	CAP, MICA, 3600 PF +/-2%, 500V	176644	72136	DM19F362G	1		
C16	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	5		
C17	CAP, MICA, 8 PF +/-10%, 500V	216986	72136	DM15C080K	1		
C18	CAP, MICA, 15 PF +/-5%, 500V	148569	72136	DM15C150J	3		
C19	CAP, MICA, 1000 PF +/-5%, 500V	148387	72136	DM19F102J	2		
C20	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C21	CAP, MICA, 2 PF +/-0.5%, 500V	175208	72136	DM15C020E	1		
C22	CAP, MICA, 1000 PF +/-5%, 500V	148387	72136	DM19F102J	REF		
C23	CAP, TA, ELECT, 15 UF +/-10%, 20V	153056	56289	150D156X0020B2	4		
C24	CAP, VAR, 1.7-10 PF, 250V	321109	56289	GKB10000	1		
C25	CAP, MICA, 390 PF +/-5%, 500V	148437	72136	DM15F391J	1		
C26	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C27	CAP, MYLAR, 0.0033 UF +/-10%, 50V	402867	06001	75F1R5A-333	2		
C28	CAP, POLY FILM, 0.01 UF +/-10%, 400V	402818	73445	C280MAF/A10K	1		
C29	CAP, MYLAR, 0.022 UF +/-10%, 250V	234484	73445	C280MAE/A22K	2		
C30	CAP, MYLAR, 0.0068 UF +/-20%, 200V	106070	56289	192P68202	1		
C31	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C32	CAP, MYLAR, 0.033 UF +/-10%, 250V	234492	73445	C280MAE/A33K	2		
C33	CAP, MYLAR, 0.0047 UF +/-10%, 50V	260844	06001	75F1R5A347	1		
C34	CAP, MYLAR, 0.1 UF +/-10%, 100V	393439	73445	C280MAH/A100K	REF		
C35	CAP, MYLAR, 0.033 UF +/-10%, 250V	234492	73445	C280MAE/A33K	REF		
C36, C37	CAP, TA, ELECT, 15 UF +/-10%, 20V	153056	56289	150D156X0020B2	REF		
C38	CAP, MICA, 4 PF +/-0.5%, 500V	190397	72136	DM15C040E	2		
C39	CAP, TA, ELECT, 15 UF +/-10%, 20V	153056	56289	150D156X0020B2	REF		
C40	CAP, MICA, 15 PF +/-5%, 500V	148569	72136	DM15C150J	REF		
C41	CAP, MYLAR, 0.022 UF +/-10%, 250V	234484	73445	C280MAE/A22K	REF		
C42	CAP, MYLAR, 0.0033 UF +/-10%, 50V	402867	06001	75F1R5A-333	REF		
C43	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D68X0035HA1	1		
C44	CAP, MICA, 4 PF +/-0.5%, 500V	190397	72136	DM15C040E	REF		
C45	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C46	CAP, MICA, 15 PF +/-5%, 500V	148569	72136	DM15C150J	REF		
C47	CAP, MYLAR, 0.001 UF +/-10%, 200V	159582	56289	192P10292	1	1	
CL1	DIODE, FET, CURRENT REGULATOR	429373	89536	429373	1		
CR2-CR5	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	8	2	
CR6, CR7	DIODE, SI, LO-CAP, LO-LEAKAGE	375907	07263	FD7222	4	1	

Table 609A-6. RMS Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
CR8	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR9	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR10	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR11	DIODE, ZENER	246611	07910	1N961B	4	1	
CR14	DIODE, SI, SM SIG	313247	28484	HP5082-6264	2	1	
CR15	DIODE, ZENER	246611	07910	1N961B	REF		
CR16	DIODE, SI, SM SIG	313247	28484	HP5082-6264	REF		
CR17	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR18	DIODE, ZENER	246611	07910	1N961B	REF		
CR19	DIODE, SI, 75 MA, 90 PIV	260554	07910	CD55105	1	1	
CR20	DIODE, SI, LO-CAP, LO-LEAKAGE	375907	07263	FD7222	REF		
CR21	DIODE, ZENER	260695	07910	1N754A	2	1	
CR22	DIODE, ZENER	260695	07910	1N754A	REF		
CR24	DIODE, ZENER	246611	07910	1N961B	REF		
CR25	DIODE, SI, LO-CAP, LO-LEAKAGE	375907	07263	FD7222	REF		
H1	SCREW, RH FILISTER, 6-32 X 1/2 (NOT SHOWN)	115006	89536	115006	3		
H2	SCREW, RHP, 4-40 X 3/8	256164	89536	256164	1		
K1	RELAY ASSY						
	COIL, REED RELAY	272070	71707	UD-6-P	2		
	SWITCH, DRY REED	284091	95348	MR138	5		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	FOIL WRAP	313833	89536	313833	5		
	FOIL WRAP	313833	89536	313833	REF		
K2	RELAY ASSY						
	COIL, REED RELAY	269019	71707	U-6-P	1		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	FOIL WRAP	313833	89536	313833	REF		
K4	RELAY, DRY REED	357566	71707	UF40069	4		
K5	RELAY, DRY REED	357566	71707	UF40069	REF		
K6	RELAY, DRY REED	357566	71707	UF40069	REF		
K7	RELAY ASSY						
	COIL, REED RELAY	272070	71707	UD-6-P	REF		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	FOIL WRAP	313833	89536	313833	REF		
	FOIL WRAP	313833	89536	313833	REF		
K8	RELAY, DRY REED	357566	71707	UF40069	REF		
MP1	CASE MODULE ASSY (INCLUDES MP2-MP9)	425231	89536	425231	1	1	
MP2	CASE HALF	402990	89536	402990	2		
MP3	CASE HALF	402990	89536	402990	REF		
MP4	COVER, MODULE CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	468462	89536	468462	REF		
MP6	DECAL, AC/DC CONVERTER (RMS)	413401	89536	413401	REF		
MP7	DECAL CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP10	FEED-THRU, TEFLON	281865	12615	SL-841-777	4		
MP11	HEATSINK	347740	05820	260-18D	1		
MP12	INSULATOR, SHIELD (not shown)	426932	89536	426932	1		

Table 609A-6. RMS Converter PCB Assembly (cont)

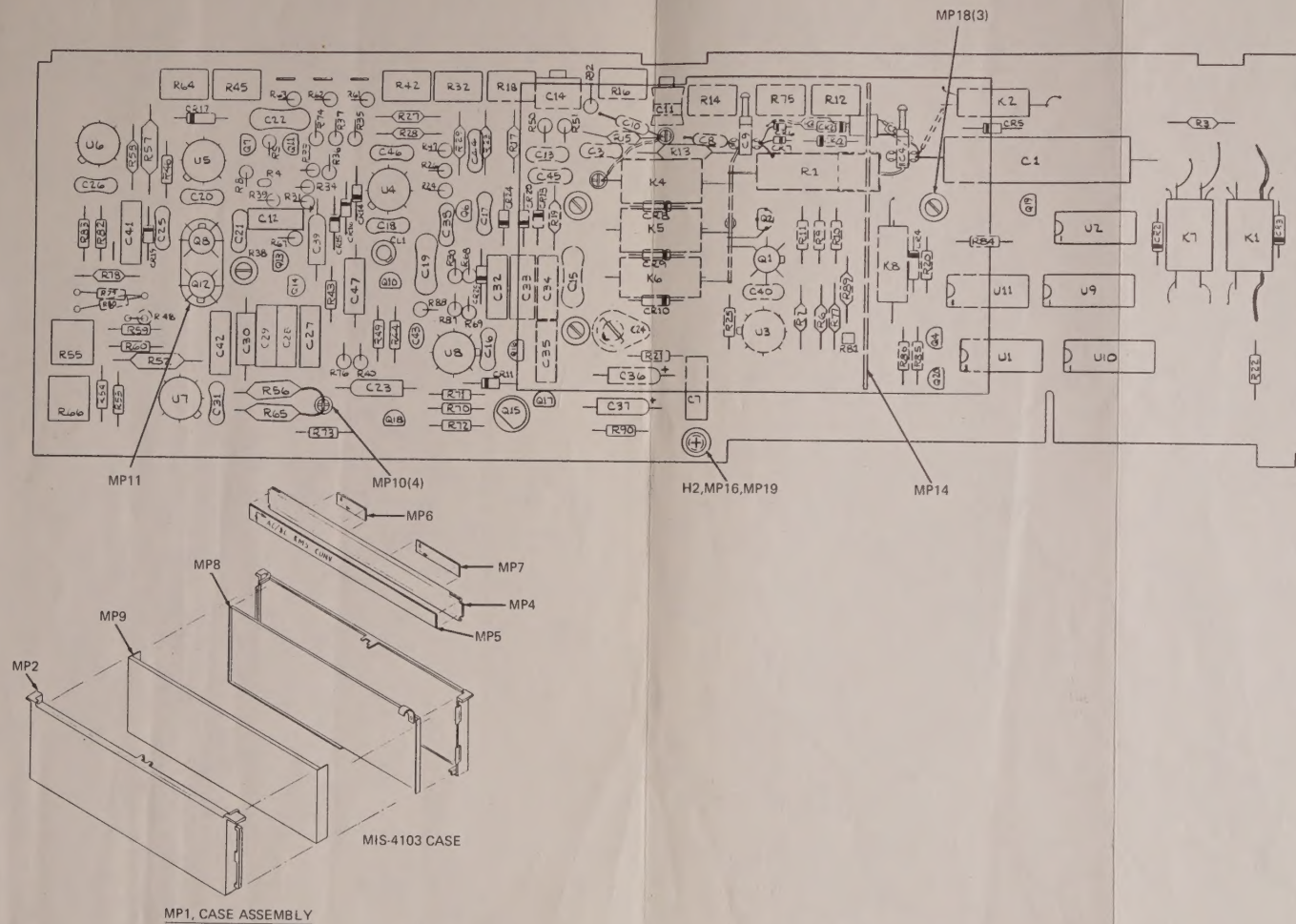
REF DES	DESCRIPTION	FLUKE STOCK NO	MFG SPLY CODE	MFG PART NO OR TYPE	TOT QTY	REC QTY	W O T E
MP13	SHIELD (not shown)	416214	89536	416214	1		
MP14	SHIELD, INPUT (not shown)	468470	89536	468470	REF 1		
MP15	SOCKET (not shown)	343285	00779	2-331272-6	7		
MP16	SPRING, COIL	424465	89536	C0120-014-0380	REF 1		
MP17	STAND-OFF, TEFLON (not shown)	275719	15849	1497E	3 REF		
MP18	STANDOFF	423806	89536	423806	3		
MP19	SPACER, STANDOFF, 4-40	334604	89536	334604	1		
MP20	TERMINAL, TEST POINT (not shown)	179283	89536	179283	4		
Q1	XSTR, FET, DUAL, N-CHANNEL	287623	89536	287623	1		
Q2	XSTR, FET, N-CHANNEL	343103	89536	343103	3	1	
Q4	XSTR, SI, NPN	218396	04713	2N3904	4	1	
Q6, Q7	XSTR, FET, N-CHANNEL	343103	89536	343103	REF		
Q8	XSTR, MATCHED SET (Q8 & Q12)	504191	89536	504191	1	1	2
Q10	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q11	XSTR, SI, PNP	195974	04713	2N3906	1		
Q12	XSTR, (part of Q8 set)						
Q13	XSTR, FET, N-CHANNEL	288324	89536	288324	3		
Q14	XSTR, FET, N-CHANNEL	393314	89536	393314	1		
Q15	XSTR, SI, PNP	218388	07236	2N3645	1		
Q16, Q17	XSTR, FET, N-CHANNEL	288324	89536	288324	REF		
Q18, Q19	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q20	XSTR, SI, PNP	226290	04713	MPS3640	1		
R1	RES, MTL. FILM, 1M +/-0.1%, 1W	340265	89536	340265	1	1	
R2	RES, MTL. FILM, 16.9K +/-1%, 1/8W	267146	91637	CMF551692F	1		
R3	RES, DEP. CAR, 200 +/-5%, 1/4W	193482	80031	CR251-4-5P200E	1		
R4	THERMISTOR, TEMP SENS, NEG TC	501304	89536	501304	1		
R5	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	2		
R6, R7	RES, MTL. FILM, 50K +/-0.1%, 1/8W	340257	91637	CMF555002B	3		
R8	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R9	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	5		
R10	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	1		
R11	RES, DEP. CAR, 12K +/-5%, 1/4W	348847	80031	CR251-4-5P12K	1		
R12	RES, VAR, CERMET, 1M +/-10%, 1/2W	334722	89536	334722	3		
R13	RES, MTL. FILM, 399.0K +/-0.1%, 1/8W	417212	91637	CMF553993B	1		
R14	RES, VAR, CERMET, 5K +/-10%, 1/2W	288282	89536	288282	1		
R15	RES, MTL. FILM, 56.89K +/-0.1%, 1/8W	417220	89536	417220	1		
R16	RES, VAR, CERMET, 500 +/-10%, 1/2W	291120	89536	291120	1		
R17	RES, MTL. FILM, 6324 +/-0.1%, 1/8W	417238	89536	417238	1		
R18	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285100	2		
R19	RES, MTL. FILM, 782.8 +/-0.1%, 1/8W	417246	89536	417246	1		
R20	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	2		
R21	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	1		
R22	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	3		

Table 609A-6. RMS Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N O T E
R23	RES, MTL. FILM, 4.975K +/-0.1%, 1/8W	340232	89536	340232	1		
R24	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	1		
R25	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K	1		
R26	RES, DEP. CAR, 3.9K +/-5%, 1/4W	342600	80031	CR251-4-5P3K9	1		
R27	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F	2		
R28	RES, MTL. FILM, 121 +/-1%, 1/8W	343160	91637	CMF551210F	1		
R29	RES, MTL. FILM, 5K +/-0.1%, 1/8W	340240	91637	CMF555001B	1		
R30	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	3		
R31	RES, MTL. FILM, 50K +/-0.1%, 1/8W	340257	91637	CMF555002B	REF		
R32	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285100	REF		
R33	RES, MTL. FILM, 100K +/-0.1%, 1/8W	340166	91637	CMF551003B	1		
R34	RES, MTL. FILM, 35.7K +/-1%, 1/8W	288480	91637	CMF553572F	1		
R35	RES, DEP. CAR, 620K +/-5%, 1/4W	442509	80031	CR251-4-5P620K	1		
R36	RES, DEP. CAR, 82 +/-5%, 1/4W	442277	80031	CR251-4-5P82E	1		
R37	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	REF		
R38	RES, VAR, CERMET, 3 +/-25%, 1/2W	347963	32997	3329H-J81-3R0	1		
R39	RES, SELECTED						2
R40	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	REF		
R42	RES, VAR, CERMET, 1M +/-10%, 1/2W	334722	89536	334722	REF		
R43	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	3		
R44	RES, DEP. CAR, 9.1K +/-5%, 1/4W	441691	80031	CR251-4-5P9K1	1		
R45	RES, VAR, CERMET, 1M +/-10%, 1/2W	334722	89536	334722	REF		
R46	RES, DEP. CAR, 560 +/-5%, 1/4W	385948	80031	CR251-4-5P560E	3		
R47	RES, DEP. CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51K	1		
R48	RES, SELECTED						2
R49	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	REF		
R50	RES, CAR. DEP, 2.7 +/-5%, 1/4W	442061	80031	CR251-4-5P2E7	1		
R51	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R52	RES, MTL. FILM, 4.02M +/-1%, 1/4W	417253	91637	CMF604024F	1		
R53	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R54	RES, DEP. CAR, 560 +/-5%, 1/4W	385948	80031	CR251-4-5P560E	REF		
R55	RES, VAR, CERMET, 1M +/-10%, 1/2W	276691	89536	276691	2		
R56	RES, MTL. FILM, 2M +/-0.25%, 1/2W	327502	91637	CMF652004C	2		
R57	RES, MTL. FILM, 930K +/-0.25%, 1/4W	417345	91637	CMF609303C	1		
R58	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F	REF		
R59	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R60	RES, DEP. CAR, 560 +/-5%, 1/4W	385948	80031	CR251-4-5P560E	REF		
R61	RES, MTL. FILM, 17.4K +/-1%, 1/8W	236802	91637	CMF551742F	1		
R62	RES, MTL. FIL, 34K +/-1%, 1/8W	261602	91637	CMF553402F	1		
R63	RES, MTL. FILM, 68.1K +/-1%, 1/8W	236828	91637	CMF556812F	1		
R64	RES, VAR, CERMET, 20K +/-10%, 1.2W	291609	89536	291609	1		
R65	RES, MTL. FILM, 2M +/-0.25%, 1/2W	327502	91637	CMF652004C	REF		
R66	RES, VAR, CERMET, 1M +/-10%, 1/2W	276691	89536	276691	REF		
R67	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R68	RES, DEP. CAR, 200K +/-5%, 1/4W	441485	80031	CR251-4-5P200K	1		
R69	RES, DEP. CAR, 750K +/-5%, 1/4W	442525	80031	CR251-4-5P750K	1		
R70	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R71	RES, DEP. CAR, 470K +/-5%, 1/4W	342634	80031	CR251-4-5P47CK	1		
R72	RES, DEP. CAR, 22K +/-5%, 1/4W	348870	80031	CR251-4-5P22K	1		
R73	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		

Table 609A-6. RMS Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N O T E
R74	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	2		
R75	RES, VAR, CERMET, 10K +/-10%, 1/2W	285171	89536	285171	1		
R76	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R77	RES, MTL. FILM, 23.2K +/-1%, 1/8W	291351	91637	CMF552322F	1		
R78	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	CMF55A100F	1		
R79	RES, SELECTED						2
R80	RES, SELECTED						2
R81	RES, THERMISTOR, TEMP SENSITIVE	104596	73168	JA41J1	1		
R82	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R83	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	REF		
R84	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		
R85	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R86	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R87, R88	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R89	RES, MTL. FILM, 42.2K +/-1%, 1/8W	221655	91637	CMF554222F	1		
R90	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R92	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
U1⊗	IC, C-MOS, NAND GATES	375147	02735	CD4023AE	1	1	
U2	IC, TTL, HEX INVERTER, BUFFER/DRIVER	288605	01295	SN7416N	1	1	
U3	IC, LIN, OP AMP	329912	12040	LM318H	1	1	
U4	IC, OP AMP	225961	24355	AD3092	1	1	
U5	IC, LIN, OP AMP	288928	12040	LM308AH	1	1	
U6, U7	IC, LIN, OP AMP	284760	12040	LM308H	2	1	
U8	IC, LIN, OP AMP	381889	12040	LM201AH	1	1	
U9⊗	IC, C-MOS, HEX BUFFER/INVERTER	381848	20735	CD4049AE	1	1	
U10⊗	IC, C-MOS, HEX "D" FLIP FLOP	404509	12040	MM74C174N	1	1	
U11⊗	IC, C-MOS, QUAD 2-INPUT NAND GATE	355198	04713	MC14011CD	1	1	
XQ15	SPACER, COMPONENT	152207	07047	10123DAP	1		
1	ORDER P/N 425281 FOR COMPLETE MODULE CASE ASSY., WITHOUT PCB ASSY.						
2	RESISTORS ARE TC COMPENSATED AND MUST BE RETURNED FOR RESELECTION IF ANY REQUIRE REPLACEMENT. (R39, R48, R79 & R80)						



MIS-1703

Figure 609A-3. RMS Converter PCB Assembly

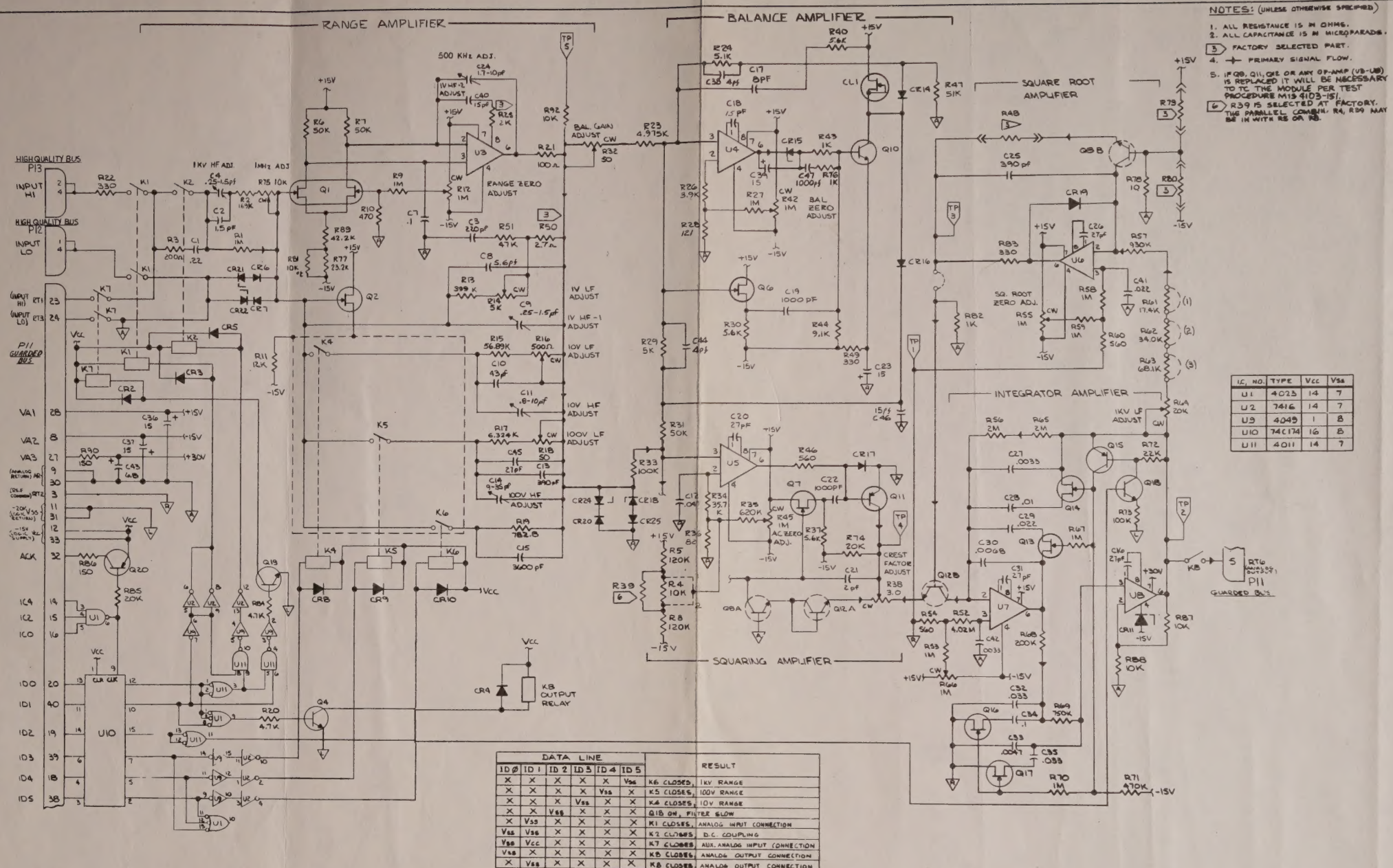


Figure 609A-3. RMS Converter PCB Assembly (cont)

